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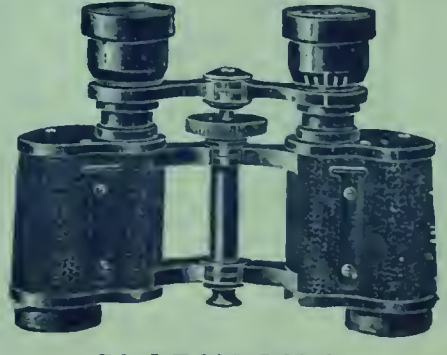

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## SOME NOTES ON THE BIOLOGY OF THE LARGER BRITISH FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(*Continued from page 137.*)

THERE are also many other fungi which are the causes of important and serious diseases of timber-producing trees; a few of them are here illustrated. The Stumptuft (*Armillaria mellea*), which will attack, not only conifers (pines), but also most other forest trees, has already been mentioned (see page 130). The Birch Polyporus (*Polyporus betulinus*) (see Figure 134) kills young birch trees within three or four years of the first infection by its spores. The Beefsteak Fungus (*Fistulina hepatica*) (see Figure 136) appears on an oak as a strawberry-like knob, which develops into a thick, succulent, shelf-like projection bearing the tubes from which the spores are formed on its lower surface. The mycelium usually takes several years to destroy the oak tree on which it grows. The Prickly Cap (*Pholiota squarrosa*) (see Figures 132 and 133) grows on trees and stumps, and is probably a true parasite. *Polyporus schweinitzii* (see Figures 137 and 138) is a large fleshy fungus which comes up in the neighbourhood of pine trees. So rapid is its development that grass, twigs, and even at times living snails are surrounded and enclosed by it. It is sometimes found quite close to the base of the tree on which its mycelium grows, and when coming up further away mycelial connections can always be traced with some root of a tree. The fungus is very destructive to pines and larches.

There are also fungi which grow parasitically on members of their own class. *Nyctalis* is a toadstool which is found growing on other toadstools. The small incompletely expanded caps of *Nyctalis parasitica* are seen in Figure 139 growing as a parasite on a species of *Russula*. When the little caps open out the appearance is most curious. There is a variety of truffle (*Elaphomyces variegatus*) (see Figure 140) which is fairly common in woods, and forms its fructifications just beneath the ground. These are very frequently infected by a species of *Cordyceps* (see Figure 141) the fruits of which appear above the surface of the soil as little yellowish-brown clubs. These last are found to be invariably attached to the truffle, and the mycelium from which they spring can be traced inside it.

There are several other species of *Cordyceps* which attack and destroy living insects. The caterpillar fungus (*Cordyceps militaris*) (see Figure 135) is one of these. The fungus grows parasitically on caterpillars, and its spores reach the insect's body, either through the spiracles or by being swallowed with its food; but the insect is not killed at once, for infection takes place very slowly, and the chrysalis stage is usually reached before the creature is finally destroyed. Its body is then replaced by a dense web of fungus mycelium; but even in this state the outward form of chrysalis

is still, as a rule, maintained, though it was lost in the specimen photographed. In autumn the bright red fructification shown in the photograph appears above the surface of the ground in which the remains of the chrysalis lie buried. A larger form (*Cordyceps sinensis*) is sold in bundles, with the caterpillar still attached, as a regular article of diet in China.

Certain fungi are constantly associated with the roots of several of the higher plants. This association, called "Mycorrhiza," has been observed especially in connection with members of the order Cupuliferae (willows, poplars, beech, and so on), and in a good many orchids and pines. *Monotropa* (see Figure 143) is a degenerate flowering plant which is entirely devoid of all chlorophyll, and has therefore to obtain all its food ready-made from the soil. In it the connection between fungus and higher plant in the *mycorrhiza* is so close that *Monotropa* has lost practically everything that can be described as an ordinary root. It is probable that in *mycorrhiza* the union between the fungus and the higher plant is in the truest sense a coöperation, and that both partners derive benefit from the union. Sometimes the fungus threads are found inside the cells of the higher plant; sometimes only between and around. They are usually most abundant where there is plenty of humus in the soil, and probably assist the plant in the absorption of water, as well as organic substances and mineral matter. This form of partnership is probably a very old one, for fossil *mycorrhizae* have been found in connection with some of the plants of the Coal Measures. As the fungi forming *mycorrhizae* but rarely form fructifications, little is known of the exact nature and affinities of most of them; but the mycelium of a species of Elaphomyces is said to form the *mycorrhiza* of some conifers, and that of a Nectria has been stated to act in a similar capacity in connection with the roots of certain orchids.

It is well known that bacteria are found within the tissues of some flowering plants, particularly of the natural order Rubiaceae, throughout their whole life-history, and that they appear to be quite harmless to their hosts. Similar instances are recorded with regard to fungi. Within the tissues of the darnel, ryegrass, and Italian ryegrass (*Lolium temulentum*, *perenne*, and *italicum*), three common meadow grasses, the mycelium of a fungus is often found. As the grass grows, so does the fungus; and when seeds are formed the fungus threads enter these, and remain dormant in them until they germinate in the spring. Some eighty per cent. of commercial samples of darnel seeds are infected with the fungus, which is therefore widely distributed, but not universal. There are, indeed, two distinct races of these three grasses, the infected and the uninfected; but so perfect has the copartnership, or symbiosis, become that the infected plants are actually more healthy and vigorous than the uninfected. From the point of view of the fungus, the coöperative existence would appear to be so satisfactory that spore-production of every kind has been given up, and the fungus is reproduced entirely by the hibernating mycelium, which is carried from generation to generation in the seed. As there are no reproductive bodies, the nature of the fungus cannot be determined.

Fungi differ greatly in consistence. Some are as hard and dry as boxwood (see Figures 142 and 144); others are as soft as jelly, and contain ninety per cent. or more of water (see Figures 145 and 146). Fungi contain large quantities of a variety of cellulose, called "fungus cellulose"; glycogen is also very often found in them, and glucose, mannite, and other sugars are frequently present. The cap and stem of *Boletus edulis* (see Figure 149) contain sugar, but this substance is absent from the tubes, and perhaps it is for this reason that, while the flesh of this toadstool is often found eaten by slugs, the spore-bearing tubes are hardly ever touched. Fats and fatty acids are present in varying proportions in different species, and amount to six per cent. in *Lactarius deliciosus*. The percentage of mineral salts is also high, and reaches six to twelve per cent. of the dry solids. The salts are mainly those of potassium, with smaller quantities of iron and manganese. Fungi also contain a relatively high proportion of nitrogen, and from two to five per cent. of the dry solids consist of this element. Only about one-half of the nitrogen is, however, combined as proteid, and only one-seventh of it is digestible proteid. It will thus be seen that the edible fungi are not in reality as nourishing as was at one time supposed. The percentages of digestible proteids, carbohydrates, and fats present in the mushroom—the most nourishing of the fungus tribe—are almost identical with those of cabbage—a vegetable that can usually be much more safely eaten. Several fungi also contain poisons, or substances which rapidly change to poisons in the earliest stages of decomposition. Though very deadly, the poisons are often present in minute quantities only, and it is said to require about two hundred pounds of the poisonous Fly Agaric (*Amanita muscaria*) (see Figure 119 on page 136) to produce one ounce of muscarine—its poisonous principle. Oxalate of lime is present in the walls of the hyphae of many fungi, and is said to be of value as a protection against slugs; it is especially abundant in the mycelium of the Stinkhorn (*Phallus impudicus*) (see Figure 148). Tannin has probably a similar function. It exists especially in the outer hyphae of sclerotia and rhizomorphs. The growing hyphae of many parasitic forms also contain enzymes and ferments capable of dissolving starch and removing the lignin from woody cells.

One of the most striking things about a good

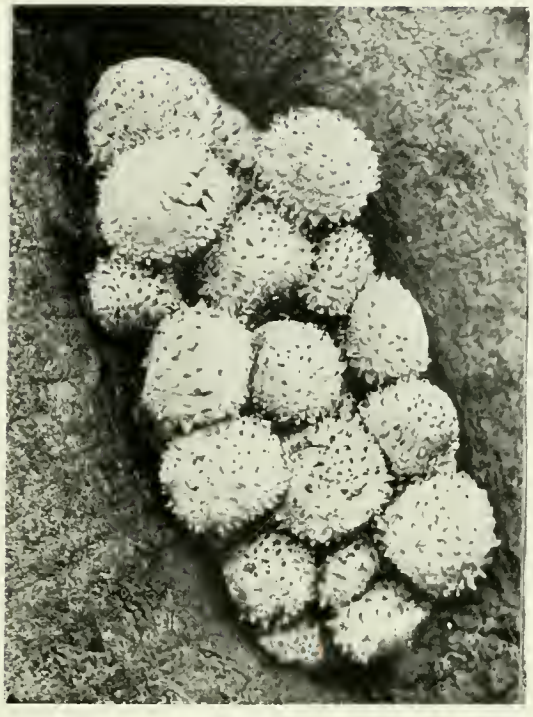

FIGURE 132. Incompletely expanded fructifications of "The Prickly Cap" (*Pholiota squarrosa*) protruding from a hole in a hollow tree.

FIGURE 134. The Birch Polyporus (*Polyporus betulinus*) is a destructive parasite.

FIGURE 133. The specimen shown in Figure 132 after its removal from the tree.

FIGURE 135. The Caterpillar Fungus (*Cordyceps militaris*) × 2, which grows parasitically on the larvae of butterflies and moths.

FIGURE 136. The Beef-steak Fungus (*Fistulina hepatica*) grows parasitically on oak trees.

FIGURE 139. A small toadstool (*Nyctalis parasitica*) which grows as a parasite on other larger toadstools.

FIGURE 137. *Polyporus schweinitzii* growing parasitically from the roots of a pine tree.

FIGURE 140. The False Truffle (*Elaphomyces variegatus*).

FIGURE 138. Fructification of *Polyporus schweinitzii*.

FIGURE 141. *Cordyceps ophioglossoides*, a parasite on the False Truffle (*Elaphomyces variegatus*).

FIGURE 142. A hard, dry fungus (*Daldinia concentrica*).

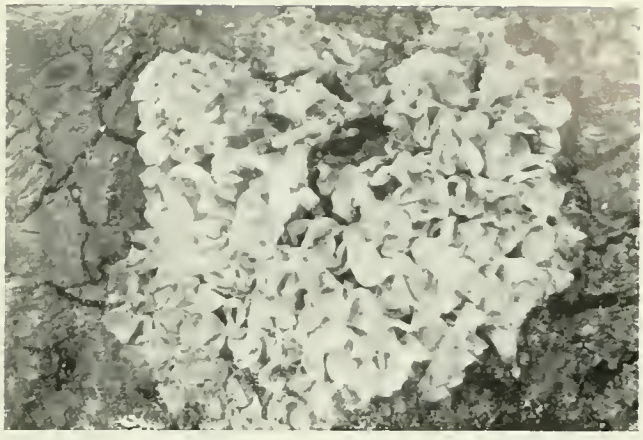

FIGURE 145. *Tremella frondosa*, a soft jelly-like form.

FIGURE 143. *Monotropa Hypopitys*, a degenerate flowering plant associated with a mycorrhiza.

FIGURE 146. "Witches' Butter" (*Exidia glandulosa*), a gelatinous fungus which grows on trees.

FIGURE 144. The Sealing-wax Fungus (*Fomes lucidus*), a hard, dry form.

FIGURE 147. *Peziza aëruginosa*, which is responsible for the green colour of fallen oak boughs.

FIGURE 148. The Stinkhorn (*Phallus impudicus*), with a small portion of its mycelium still attached to it.

FIGURE 149. The Edible Boletus (*Boletus edulis*).

FIGURE 150. The Jew's Ear (*Hirneola auricula-judae*) is very common on old elder bushes. It is soft and gelatinous when moist, but dries up to a dark amorphous cartilaginous mass.

many fungi is their brilliant colour. About the chemistry of this but little is really known; but we are told that in many cases the colour is due to chromogenous materials, which on oxidation develop the characteristic tints. We know how rapidly the colour of some species of *Boletus* changes when the flesh is broken and exposed to the air. But it is probable that presence of light has something to do with the production of colour also, at any rate, in some species; for Fischer found that in experimental cultivation the fruits of *Armillaria mucida*, grown in the dark, were always white, while those grown in the light were grey or brown. Decaying branches of oak may often be picked up in woods, stained all through a brilliant verdigris-green colour. On the surface the wood is soft and easily broken, but further in, though it retains its brilliant colour, it is nearly as hard as ordinary wood. In the days before aniline dyes these half-decayed logs were used for the beautiful inlaid woodwork known as "Tonbridge ware." In autumn tiny green cups may often be seen growing on the fallen branches. They are the fruits of the fungus *Peziza* (*Helotium*) *aëruginosa* (see Figure 147), the mycelium of which is responsible for the bright green colour. The oak wood is penetrated in all directions by the fungus hyphae, and these contain the bright green substance which can be separated as a chemically pure crystalline material, and is thought to serve as a reserve store of nourishment for the fungus plant.

It is very difficult to understand of what value these brightly coloured substances can be to the fungi which possess them. Although a few fungi are regularly eaten in nature by animals and insects, most of them, including some of the most brightly coloured species, are practically never touched by any creatures that could possibly assist them in the distribution of their spores. Moreover, the umbrella-like form—which has proved so successful in the struggle for existence that it is found in many thousands of different species of toadstools—is so excellently adapted for the distribution of the light spores by the wind that it is difficult to imagine that it has been evolved for any other purpose. The brilliant tints of many of these toadstools would seem to be due to no mere accident, and to be something more than a method of disposal of material of no further value to the plant, as they are in most cases limited to that part of the toadstool visible from above, and are even confined in very many cases to a thin layer of tissue on the upper surface of the toadstool cap. Possibly the bright colours have been evolved for the purpose of making the toadstools conspicuous, so that they may be avoided, and neither trodden on nor eaten by accident or mistake by grazing animals.

In conclusion it may be interesting to enquire of what economic importance is the toadstool tribe; and it must be admitted at once that, from the point of view of civilised man, the fungi are of little use, and do an infinite amount of damage. Many of the most serious of the diseases of cultivated plants are due to microscopic fungi; and, as has been already described, much disease in timber is the result of the growth of parasitic toadstools—indeed, it has been stated that the world is poorer by no less than two thousand million pounds sterling every year owing to the loss of crops which have been attacked by fungus pests. Turning now to the other side of the picture, it is well known that mushrooms and toadstools are much more extensively eaten abroad than in England. But from what has already been said it will be inferred that the edible fungi must be regarded as a pleasant (though often dangerous) flavouring agent, rather than as a sustaining food. In the olden times several of the fungi were used medicinally. The familiar Jew's-ear (*Hirneola auricula-judae*) (see Figure 150) had a great reputation for the treatment of dropsy, and every wise house-wife kept a store of dried giant puffballs (*Lycoperdon giganteum*), to be applied to cuts to stop bleeding. At the present time Ergot is the only fungus regularly used in medicine; but this drug and the preparations made from it are of very real value in the treatment of disease, nor have we any other drug with similar physiological properties which can replace it. Some of the larger woody forms, such as *Fomes fomentarius*, when dried and beaten, form a soft, velvety material. Hats and slippers, blotting cases, and so on, are made from this in South-eastern Europe; and, being very absorbent, the same material, under the name of "Amadou," is used by dentists for mopping out the cavities of diseased teeth which are being stopped. Razor-strops can also be made from the woody fungi. I have a useful strop made from a piece of a large fruit body of the Birch Polyporus (*Polyporus betulinus*) (see Figure 134), which answers its purpose very well. Dried fungi have been used for tinder, and the fumes from smouldering giant puffballs served in olden times to stupefy bees before they were robbed of their honey.

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# THE GREAT ALASKAN EARTHQUAKES OF 1899.

By CHARLES DAVISON, Sc.D., F.G.S.

On September 11th, 1899, it was known in all the seismological observatories of the world that a violent earthquake had occurred in some distant region on the previous evening. From the duration of the tremors which preceded the large undulations on the different records it was ascertained that the origin of the earthquake must have been in or near Alaska, and this determination was soon verified by the arrival of meagre despatches from the central part of the disturbed area.

There for a time the matter rested. The earthquake was evidently one of the first magnitude, or it would not have been recorded in such distant regions. The damage to property, however, was insignificant, simply because there was little property to destroy. Nor was there any loss of life, for the country is almost uninhabited. Indeed, nearly six years elapsed before it became known to scientific men that the earthquake presented phenomena of the most unusual interest. Fortunately, most of these phenomena left traces that were still distinct in 1905, though others presented features that were not recognised until a year or two later.

In the summer of 1905 a party of geologists sent by the United States Geological Survey visited Yakutat Bay. The party was under the direction of the late Professor Ralph S. Tarr, with Mr. Lawrence Martin as physiographic assistant. Very early in their work they noticed dead mussels and barnacles adhering to the cliff, far above the reach of the present tides. Had the barnacles died many years ago they would have lost their hold on the rock, and indeed many of them had fallen on to ledges below. It was therefore evident that, quite recently, there must have been a considerable rise of the land, and the observers at once, and as it proved rightly, attributed the work of elevation to the crustal movements which had caused the earthquakes of 1899. In 1906 Professor Tarr again visited the district, intending to study the glaciers farther to the west, but was unable to cross them owing to their great advance and the unusually crevassed condition of their surfaces. Further observations on the effects of the earthquake on the glaciers were made by Messrs. Tarr and Martin in 1909, and again in the following year by Mr. Martin. The very valuable report on the earthquake and its effects by these two capable observers has recently been published by the Geological Survey of the United States.* As the report, however, is lengthy and somewhat inaccessible to English readers, I propose in this article to give a summary of the principal facts observed, devoting special attention to those features which distinguish the earthquake from most others with which we are acquainted. These are (i) the remarkable changes of level manifested in Yakutat Bay, the maximum uplift amounting to more than forty-seven feet, and (ii) the advance and crevassing of the glaciers, which took place principally between the years 1905 and 1910, and which may not yet have come to an end.

The earthquake disturbed the southern part of Alaska, and especially that district in which the average trend of the coast is nearly east and west. The region surrounding Yakutat Bay was that in which the severest shaking and the changes of level were manifested. The disturbed area on land contains two hundred and sixteen thousand three hundred square miles; but this can only be about half the total disturbed area, which must therefore be estimated at about four hundred and thirty-two thousand square miles. But even this amount, great as it is, must be too small; for the earthquake was felt at two isolated places to the west, which are respectively six hundred and seventy and seven hundred and thirty miles from Yakutat Bay. Thus, if the boundary of the disturbed area be regarded as a circle with a radius of seven hundred miles, the total area shaken by the earthquake must amount to about one and a half million square miles.

This figure alone gives us some conception of the violence of the earthquake. It has seldom been exceeded by any known disturbance. The great Lisbon earthquake of 1755 disturbed an area of not more than about two million square miles; the Assam earthquake of 1897, one of about one and three-quarter million square miles; the Kangra (India) earthquake of 1905, one of about one and a half million square miles. The largest known disturbed area is that of the Charleston earthquake of 1886, which must have shaken more than two and three-quarter million square miles. This earthquake, however, was not one of exceptional strength. It merely owes its extensive area of perception to the presence of a sensitive and intelligent population. On the other hand, the great Japanese earthquake of 1891 disturbed only three hundred and thirty thousand square miles, the Californian earthquake of 1906 about three hundred and seventy thousand square miles, and the Messina earthquake of 1908 about two hundred thousand square miles.

* "The Earthquakes of Yakutat Bay, Alaska, in September, 1899." By R. S. Tarr and L. Martin. *U.S. Geol. Surv.*, Professional Paper 69.

Thus, the Alaskan earthquake of 1899 must be ranked among the greatest of all recorded earthquakes.

This great earthquake, however, was not the earliest of the series. So far as known, the first earthquake occurred on September 3rd, at 3.3 p.m. local time (or September 4th, 0.22 a.m. Greenwich mean time). It was strong enough to be recorded in the seismological observatories of Europe and other distant places. There is some uncertainty as to the seat of this earthquake, but as the coast is said to have been uplifted at Yakataga, one hundred miles west of Yakutat, it is possible that the central region was in the neighbourhood of that place. During the next week about fifty slight shocks were noticed near Yakutat Bay. Then, on September 10th, came two great earthquakes, one about 8 a.m. local time, the other and greatest of all at 12.22 p.m. local time (or 9.40 p.m. Greenwich mean time). On the same day about fifty slighter shocks were observed. Both of the great shocks originated in and near Yakutat Bay, but it is probable that the uplift of the coast occurred with the later of the two, as the earlier one was not accompanied by any sea-wave. Severe shocks also occurred on September 15th, 17th, 23rd, 26th, and 29th, intercalated among a large number of minor shakings, to which little attention was naturally paid by the inhabitants of the district. At the time of the earthquakes eight persons were camped along the shores of Yakutat Bay, at the places indicated in Figure 151 by asterisks, near the foot of Variegated Glacier. They were all within a few miles of the region in which the chief uplift had occurred. The great shock is said to have lasted two and a half to three minutes, and, while it continued, the ground waved up and down like the swells of the sea, only with much more energy, and then opened in long fissures. A small lake behind broke from its bed and swept over the camp. Shortly afterwards a seismic sea-wave, about twenty feet high, swept in from the bay and completed the destruction of the camps. Many dead fishes, probably killed by the sudden shock which they would feel all over their bodies at once, were thrown up on the shore, and these supported the few observers until they were able to reach the village of Yakutat, about thirty miles distant.

### CHANGES OF ELEVATION.

In most recent earthquakes which have accompanied changes of elevation the district chiefly affected has been an inland one. The changes observed have therefore been relative only, for the trigonometrical resurveys which have been carried out have not sufficed to determine the actual movements of the ground in a vertical direction. But in Alaska most of the measurements are referred to the sea-level, and are therefore absolute. Moreover, the coast-line in this part of the country is so deeply indented by Yakutat Bay that the field of observation may be regarded as areal rather than linear. In most parts of the bay the shores have been uplifted, in some depressed, while in others no movement whatever could be detected.

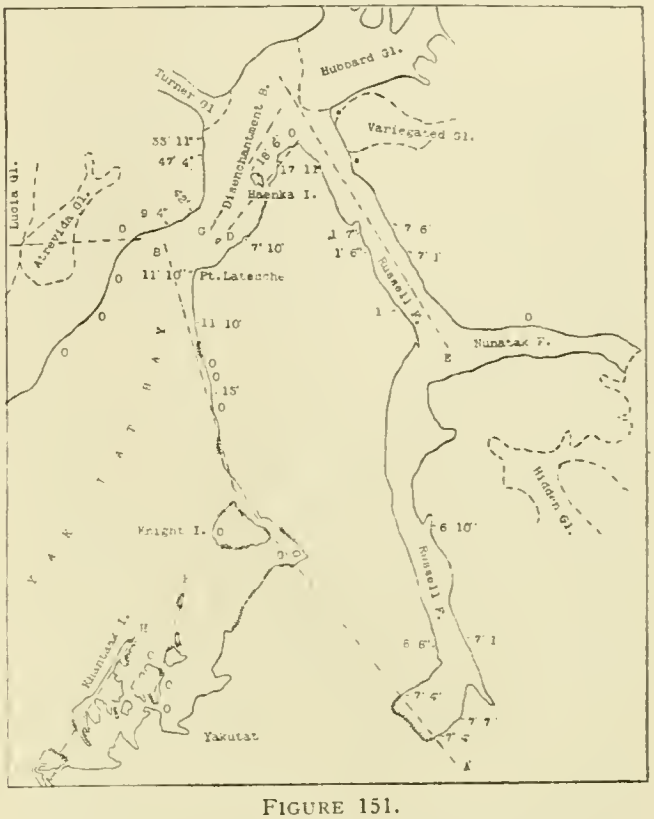



FIGURE 151.

Map of Yakutat Bay and the neighbouring country.

The form of Yakutat Bay will be seen from the map in Figure 151. On the west side the bay is bordered by a low foreland of glacial gravels. On the east side the northern half of the bay is straight and precipitous and the land behind rises abruptly to heights of three or four thousand feet. Towards the north, Yakutat Bay merges into a narrow arm, called Disenchantment Bay, which is a true fiord bounded on both sides by steep mountains. At its north end the inlet turns abruptly backwards and is afterwards known as Russell Fiord, the shores of which are at first straight and mountainous. The entire length of the inlet from the ocean to the head of Russell Fiord is about seventy miles.

To the north of Yakutat Bay the country is occupied by lofty mountain ranges, those of St. Elias and Fairweather, in the former of which the culminating peaks rise to heights of eighteen thousand and nineteen thousand five hundred feet. From these mountains extensive glaciers descend towards the sea, some of which, such as the Galiano, Atrevida, Hubbard, Nunatak, and Hidden Glaciers, will be referred to afterwards.

*Evidences of Elevation and Subsidence.*—At first sight the most striking evidence of the uplifts is the *physiographic evidence*. Before the uplift there had been a prolonged interval of rest, during which the sea had in various places cut back cliffs, planed rock-benches at their feet, and deposited

some of the material carried away in extensive beaches. In many places the rock-benches are now elevated from ten to forty feet, and form long stretches from two to forty feet in width. At the bases of the cliffs behind may be seen the sea-caves and chasms that had been worn in them before the uplift occurred. The beaches were also raised and are still preserved where they have not since been cut into by streams and waves. Sand-dunes on the west side of Disenchantment Bay have been raised beyond the reach of further supplies of sand, and in consequence grasses have soon taken root upon their surface. In 1909, or ten years after the earthquake, the belt of dunes had lost all trace of its former condition except the hummocky surface and the sandy soil.

While the cliffs were being worn back and the rock-benches planed away the streams flowing into Yakutat Bay and its branches were building up their deltas. Many of these deltas are now laid bare above the sea, and gullies are being formed in them by the streams, while the seaward slopes are being cut back by the waves into low cliffs. In Russell Fiord a small island before the earthquake used to be connected by a sand-spit with the mainland at low tide. The spit is now so much uplifted that the highest tides cannot cover it. To the north of Haenke Island there used to be two submerged reefs which before the earthquake were never visible. They are now uncovered at low tide. Again, in the cove to the south-east of Knight Island four small islets have appeared, the two largest being four hundred and fifty feet in length. The native canoemen assert that all four were submerged at high tide before the earthquakes, while two could only be seen at low tide. Two of them are now exposed at all states of the tide and the others between mid and low tides. In many other parts of the inlet, and especially on the east side of Disenchantment Bay, there are numerous channels between small reefs and stacks and the shore along which, according to the natives, boats could formerly pass, but which now are no longer navigable.

There is of course nothing in the physiographic evidence to indicate the exact date at which the uplifts described took place. That it occurred, however, not long ago is shown by the appearance of the elevated ground. In the uplifted deltas and raised beaches—that is, in ground formed of soft or loose material—streams and waves soon wore away the surface. By 1909, or within ten years, many raised beaches were destroyed, and the sand-dunes, as already mentioned, were covered with grasses. But in the rock-benches and cliffs the effect has been but slight. Chasms are just beginning to form in the cliffs at the new sea-level; but in 1905 the sea had not cut an appreciable cliff or rock-bench anywhere, and the uplifted benches are only slightly modified by the streams that flow across them.

For the purpose of measuring the extent of the uplift the *biological evidence* is even of greater service than the phenomena described above. In approaching the coast in a boat the white shells of dead barnacles are a striking feature. Many of the barnacles are still firmly attached to the rocks, the valves being often held together by the organic tissue. In places they are far more abundant than the living forms at the present sea-level. Moreover, few of the latter are more than three-eighths of an inch in diameter, while many of the dead barnacles are an inch and a half across. Dead mussels are even more abundant and almost as widely distributed as the barnacles. They resembled, and were indeed at first mistaken for, clusters of blue flowers attached to ledges eighteen feet or more above the present sea-level. They were often found adhering to the rocks by the hairlike byssus, and the preservation of so delicate a structure until 1905 is another indication of the recency of the movement. Besides barnacles and mussels, limpets were occasionally found in 1905 attached to uplifted ledges of rock. In certain parts of the west side of Disenchantment Bay there were also seen what looked from a distance like broad horizontal bands of whitewashed rock, but which proved to be the bleached remains of a pink bryozoan that grows in tidal pools and below the low-tide level.

One curious result of the uplift is the mixture in one spot of land and sea organisms. The remains of barnacles, mussels, and bryozoans, which live only in the sea, now rest in spots which have been invaded by the willow and alder, the wild geranium and other land-plants. On nearly all the raised beaches and deltas, and on some of the uplifted rock-benches, these land-plants are to be found. The scattered condition of the flowering annuals and perennials and the grasses indicates the recency of the uplift, which is clearly proved by the woody shrubs, such as the willow and the alder. These are without exception small, and of all that were cut down in 1905 none showed more than five annual rings, and most had only three or four. "Evidently," as Messrs. Tarr and Martin remark, "these shore lines had been open for occupation by land-plants for only four or five years. The earthquake was in the autumn six years before."

The destruction of life during the earthquakes of 1899 must have been very great. Numberless fishes were killed by the mere force of the shock. The seismic sea-waves, which swept over the land after the principal earthquake, uprooted trees and destroyed vegetation by saturating the roots with salt water. But, above all, there was a wholesale destruction of various marine forms—barnacles, mussels, and so on—by their uplift from the sea. When this uplift amounted to as much as ten feet or more, the intertidal animals were all killed, and their place has been supplied only scantily, if at all, by others, whose diminutive forms point to the shortness of their lives, and therefore to the recency of their migration. Thus, the state of

preservation of the beaches, cliffs, benches, and deltas in 1905; the fact that in that year countless barnacles and mussels were held together by undecayed organic tissue; the meagre numbers and undeveloped forms of their successors in the intertidal waters; and the youth of the bushes which have invaded the new shore-lines all point to the conclusion that the uplift was accomplished a few years before 1905. There is also other evidence leading to the same result. The late Professor I. C. Russell visited Disenchantment Bay and Russell Fiord in 1890 and 1891, and observed none of the shore-lines which fourteen years later were so clear. He landed with difficulty on Haenke Island, where the beach has been raised nineteen feet; at the present time it is accessible in many places. In 1895 the Canadian surveyors of the Alaskan Boundary Commission took a number of photographs in Yakutat Bay. One shows Cape Enchantment as an island. In 1905 it was a peninsula joined to the mainland by a bar that is covered only by the highest tides. Three months before the earthquake Dr. G. K. Gilbert landed upon beaches which have since been raised fifteen feet or more, and, though one of the chief authorities on abandoned shore-lines, saw no signs whatever of the uplift. On the other hand, the Alaskan natives definitely state that the uplifts occurred with the earthquakes of September, 1899, and it is important to notice that the questions put to them did not suggest the answer. Thus, it would seem almost certain that the changes of level took place on September 10th, 1899, and chiefly, if not entirely, with the second shock at noon, as this was the only earthquake followed by seismic sea-waves.

The evidences of submergence are far less numerous and less conspicuous than those of elevation, but there can be no doubt that in small areas the coast-line was depressed. In most of these trees were killed by sand being piled up round their bases, by waves washing away their foundations, or by the submergence of their roots in salt water. Figure 152 represents a portion of Khantaak Island, in which spruce trees still standing erect have been killed by submergence and by the partial burial of the trees in beach sand. It is important to notice that all the areas of submergence consist of unconsolidated deposits. In some cases it is of course possible that the submergence might be due to a settling of the deposits during the shaking, but the distribution of these areas of submergence, as will be seen later, renders it probable that the submergence was due to a real downward movement of the crust.

Again, there are large areas where little or no change of level occurred, or where the uplift, if it took place, was too small to be proved. In some cases dead barnacles were seen on a stretch of coast on which there were also living barnacles at equal heights above the present sea-level. It is possible that there may have been an uplift of a foot or less, so that some barnacles were killed, while others were kept alive by an occasional splash of salt water. On the map (see Figure 151) such areas are considered as having undergone no movement, unless there was conclusive proof of either elevation or submergence.

*Amount of Elevation and Submergence.*—We may now turn to the measurements that were made of the changes of level and their distribution along the shores of Yakutat Bay and its branches.

In the measurement of the uplift the most serviceable evidence was that provided by the dead barnacles. The vertical distance between the highest living barnacle and the highest dead barnacle still attached to the rock was taken to measure the uplift. In reality the uplift may in places have been slightly greater, for the highest living barnacles may have owed their preservation to occasional splashes of salt water, while the highest dead barnacles in 1899 may have lost their hold by 1905. The effect of the double error may be to lessen the actual uplift by from six to twelve inches. Four-fifths of the estimates of uplift were made by means of barnacles. The remainder depended on the rise of mussels and other marine forms. On the raised beaches measurements were made in a few cases of the vertical distance between two parallel lines of driftwood, but these as a rule were checked by barnacle measurements in the neighbourhood.

In the case of subsidence the measurements are probably less exact. They were generally made on the vertical distance between the base of the lowest dead tree in place and that of the highest tree or shrub which had been or was being killed by the deposition of sand and gravel around it.

From observations made along the coast in both directions for a hundred miles or more from Yakutat Bay it appears that, with two possible exceptions, the changes of level were confined to Yakutat Bay and its branches. The evidence, of course, is practically confined to the neighbourhood of the coast. With regard to the snow-covered mountainous tract to the north we have, and can have, no information whatever.

The total length of the shores of Yakutat Bay and its branches is about one hundred and fifty miles. In 1905 more than a hundred good measurements of the amount of uplift or depression were made. These show that for about fifty miles there was either no change or a very small change of level. In Figure 151 these parts of the coast are indicated by ciphers, measurements of elevation are given in feet and inches, while the depressed portions of the coast-line are indicated by shading.

A glance at this map will show how variable are the changes of level both in direction and amount. (i) There are considerable stretches of coast along which changes of elevation are either negligible or do not exist. Such are the west shore of Yakutat Bay from a point opposite Port Latouche

southwards, part of the west side of Knight Island, and most of the coast from Knight Island to within four or five miles of Port Latouche. Along the south-west coast of the main branch of Russell Fiord the uplift varies from two feet downwards. On the coasts of Nunatak Fiord the level on both sides seems unchanged. (ii) The areas of depression are much smaller. Here and there along the coast from Yakutat to Knight Island and in the neighbouring islands, in a short length of the coast to the north of Knight Island, and at the southern end of the south branch of Russell Fiord, the land has been lowered by amounts ranging up to seven or eight feet. (iii) The areas of elevation are much larger and the amounts of elevation are in some cases extraordinary. The coast from four or five miles south of Port Latouche to near the entrance to Russell Fiord has been uplifted by amounts ranging from seven and a half feet to nearly eighteen feet, and on Haenke Island by more than nineteen feet. The most remarkable uplift of all is that of the west coast of Disenchantment Bay between Turner and Black Glaciers. Here the rise ranges from thirty-seven feet to the greatest ever recorded in any earthquake — of forty-seven feet four inches. The north-east shore of the main branch of Russell Fiord has undergone a nearly uniform elevation of about seven feet, while both shores of the southern branch, except the south coast, have been raised by amounts varying from three to ten.

A remarkable feature in the changes of elevation is their rapid variation in amount over a short distance of the coast. For instance, at one point on the west coast of Disenchantment Bay the amount of the uplift is forty-two feet, about a mile to the west it is thirty feet, and about a quarter of a mile farther it is nine feet. On the east side of the same bay the uplift is seventeen feet one inch close to the north end of the peninsula; in the small island (Osier Island) just to the north of the peninsula there is no evidence of any change of level. In the main portion of Russell Fiord, which is about a mile and a half wide, the elevation is slightly more than seven feet along the east coast, and less than two feet along the opposite shore. At the southern end of the south branch of Russell Fiord the change of elevation varies suddenly from an uplift of seven feet four inches to a depression of five feet.

*Nature of the Deformation.*—Such sudden variations in the changes of level must be due either to faulting or to folding or warping. Minor faults, as will be seen, occur in many parts of the region, but no great fault-scarps have been detected such as would account for the abrupt variations. Nevertheless, it can hardly be doubted that Messrs. Tarr and Martin are correct in attributing the variations to faulting rather than to folding. They mention four facts which are opposed to the latter explanation. The lines of deformation extend in too many directions; the zones of gradation between areas of different degrees of deformation are very narrow, while the intervening areas of uplift are broad; minor faulting occurs in parts of the region; and profound faulting is proved by the occurrence of the great earthquakes.

The straight broken lines in Figure 151 represent the courses of the faults which are inferred from the variations in the changes of level. One of the most remarkable of these faults is that marked A. At its south-eastern end it crosses the head of Russell Fiord just where the uplift changes to depression, and where also there is a change in geological structure; it also passes exactly through three other areas in which uplift gives place rapidly to depression or to no change of level. To the east of this line there is a straight mountain front with truncated mountain spurs reaching out nearly to the fault-line. Another fault, B, or it may be a continuation of the same fault with a slight change of direction, runs along the east shore of Yakutat Bay, where the mountain front is straight and steep. If this line be continued across Yakutat Bay, it meets the opposite coast just to the west of the short line of coast in which the uplift changes rapidly from thirty to nine feet. The great uplift of more than forty-seven feet of the west side of Disenchantment Bay, the smaller uplift of seventeen to nineteen feet on Haenke Island and on the shore of the peninsula to the north of it, and the still smaller uplift of seven to nine feet along most of the east side of Disenchantment Bay are explained by two faults, C and D, one on either side of Haenke Island. A fifth fault, E, must follow the course of the main portion of Russell Fiord, for the eastern shore consists of crystalline rocks which were elevated seven feet or more, while the western shore consists of unmetamorphosed rocks which were uplifted by less than two feet. In addition to these five faults, the evidence for which is distinct, Messrs. Tarr and Martin attribute other displacements to three smaller faults, two, F and H, in the islands near Yakutat, and one, G, on the west side of Yakutat Bay.

(*To be concluded.*)

## MISTLETOE ON THE OAK.

As mistletoe very rarely grows on Oak trees, Figures 155 and 156, which are from photographs taken by the Rev. George Sampson, are of considerable interest. The tree shown is growing at Hackwood Park, the property of Lord Bolton, and now occupied by Lord Curzon of Kedleston. The Oak belongs to the species *Quercus pedunculata*, and is about fifty feet in height.

FIGURE 152.
Submerged Coast on east shore of Khantaak Island.

FIGURE 153.
Fault Scarp, 4½ feet high, on Nunatak, at head of Nunatak Fiord.

FIGURE 154.
Parallel Minor Faults, 2 to 10 feet apart, on Nunatak, at head of Nunatak Fiord.

*From photographs by*

*the Rev. George Sampson, M.A.*

FIGURE 155. FIGURE 156.
Mistletoe on the Oak (*Quercus pedunculata*).

FIGURE 157.

Germinated oöspore of *Oedogonium*, showing 4 zoöspores ready to escape.

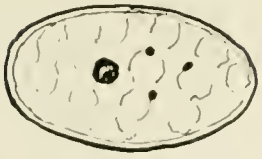


FIGURE 158.

Zygote of *Spirogyra* in which the nucleus has divided into 4, 3 daughter nuclei degenerating.

FIGURE 159.

The archegonium and fertilisation in the Bryophyta.

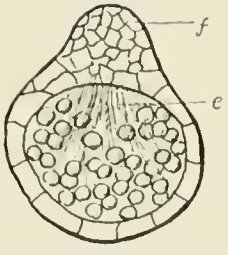



FIGURE 160.

Higher type of sporogonium, showing some sterilisation: *f* absorbing foot, *e* mass of elaters.

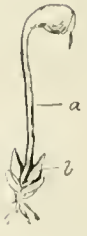



FIGURE 161.

A Moss plant—two generations. The sporophyte *a* is dependent on the gametophyte *b*.

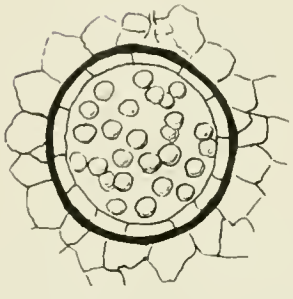


FIGURE 162.

The type of "fruit-body," or sporogonium, found in *Riccia*, and so on.

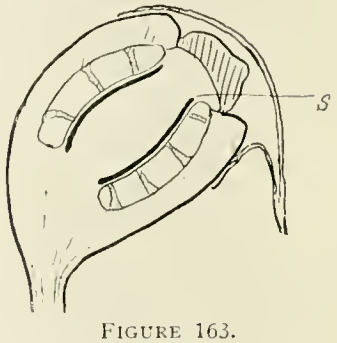



FIGURE 163.

Section of capsule of Moss, showing the relatively great amount of sterile tissue. S=the spore-producing layer.

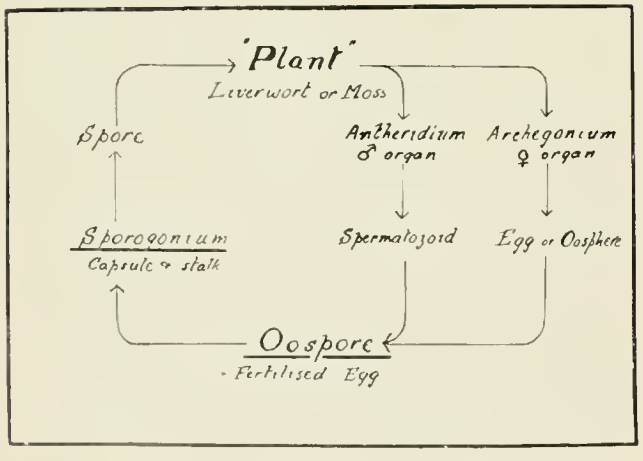



FIGURE 164.

Illustrates diagrammatically the life-cycle of a Liverwort or Moss. The sporophyte generation is underlined.

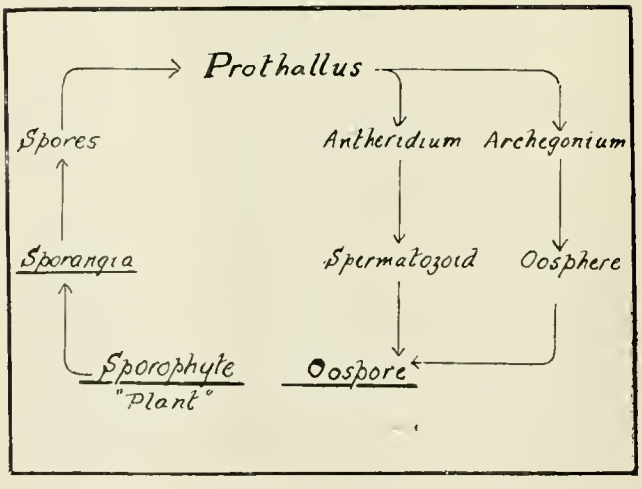



FIGURE 165.

Life-cycle of a typical Fern. Sporophyte underlined as in Figure 164.

# PROBLEMS OF PLANT LIFE.

## II. THE ORIGIN AND EVOLUTION OF THE HIGHER PLANTS.

By S. REGINALD PRICE, M.A. (Cantab).

In a previous article * some short account was attempted of the possible lines of evolution which may have resulted in our present Algal flora, and it was there mentioned that there is good reason to suppose that some such Alga-like plants represented the earliest members of the plant kingdom. If this were the case the so-called " Higher Plants " must have descended from these Algal-like ancestors. As was there indicated also, the Flagellata are probably to be regarded as a plexus of organisms, which represents the nearest approach that we can imagine to the primitive group of both animal and vegetable life. Some of the processes which probably took place in the evolution of the Green Algae were briefly outlined and the question now arises—What has been the course of evolution from these lowly plants to the Higher Plants that we know to-day? An answer to this question is still impossible, but biological speculation has been rife on the subject. It may thus be of interest to state in outline some of the main bearings of the problem, and to indicate briefly to what extent our present knowledge can deal with it.

The organisation of the highest plants of which we are speaking is very much more complex than that of the simple water forms existing, for example, in the Green Algae, and at first sight the difference seems too great for any relation whatever to be possible between the two. However, in the Algae themselves, especially in the " coloured seaweeds," there are numbers of species existing which show a high organisation of body structure, and indicate at once the possibility of upward evolution for the group. Such forms, for example, as *Fucus*, the Bladder-wrack, and *Laminaria* of the brown seaweeds (Phaeophyceae) show a differentiation of the body into fixing and assimilating or leaf-like portions, and have organised definite conducting and assimilating tissues. In fact, in organisation of the body some of these higher seaweeds seem to be more advanced than some of the lower liverworts, a section of the Bryophyta which must be regarded as the lowest true group of the land flora.

The most far-reaching and important change which we have to trace is that of habit, from primitively aquatic to land-living forms; and still, at the present day, a large number of land types retain characters which are only to be regarded as descended from aquatic ancestors. Thus, for example, the motile male cell is universal throughout the Bryophyta and Pteridophyta, so that at the time of fertilisation an aquatic environment is necessary, though this need be no more than a film of dew or a rain-drop!

The Higher Plants, which constitute very largely the terrestrial flora, comprise practically the three great groups: the Moss Plants or Bryophyta, the Fern Plants or Pteridophyta, and the Seed Plants or Spermaphyta, which include the flowering plants. A few of these are, of course, aquatic in habit, but there is every reason to believe that they are only secondarily so, and have descended from previous land-living ancestors.

These great groups as they exist to-day are sufficiently sharply differentiated in character from one another. There is no space here to deal with the features which characterise the groups—types from each will, at any rate, be familiar to every biologist. One or two features which are of great importance must be emphasised in considering this problem of evolution.

The first is bound up in the phenomenon of Alternation of Generations. Suppose we consider a plant bearing sexual organs, the egg after fertilisation—the oöspore—may germinate to produce a plant like the first, or it may produce another phase or generation which bears only asexually produced spores. Generally speaking, in the Higher Plants the latter is the case, and the life-cycle is more or less obligate †—the oöspore produces the spore-bearing phase or " Sporophyte," and the spores on germination produce the sexual organ-bearing phase or " Gametophyte." This is illustrated in the diagram of the normal life-cycle of a common moss, say *Funaria* or *Polytrichum* (see Figure 164). This regular alternation of phases is what is called " Alternation of Generations in the Higher Plants."

In the Bryophyta the sporophyte is represented by the capsule and stalk, or sporogonium, which is produced as a development of the oöspore and remains dependent on the gametophyte. The gametophyte is the real free-living and self-supporting generation. In the Pteridophyta almost the reverse is the case, for the sporophyte is independent after its embryonic stage, while the gametophyte is a little, short-lived, independent structure—the prothallus. In some cases there are two gametophytes which bear the different sexual organs. There is thus a sharp contrast between the two

* " Knowledge," June, 1913, " Evolution among Lowly Forms (the Algae)," pages 201-204.

† See, *e.g.*, Bower, " Origin of Land Flora."

groups in this respect, and, as we shall see, this has an important bearing on the problem under discussion. In the Spermaphyta the gametophytes —more especially the female—are dependent on the sporophyte. Our problem is to show how these groups are related to one another and to the supposed primitive aquatic flora.

As was indicated in the previous article, a series of living forms cannot represent a true evolutionary series, and evidence derived from such must be used with caution. Hence attention is turned to fossil forms which have thrown much light on the relationships of living forms, especially in the Pteridophyte. Fossil Algae are, however, often of doubtful determination, and give few clues to structure, so that on the subject of the first stages of evolution from the Algal to land types the record of the rocks is very imperfect, or, from the delicacy of the forms, is perhaps non-existent. In such a case we can only turn to biological reasoning founded on existing types, using the principles of progressive evolution.

In some respects, the Bryophyta appear to be more nearly allied to the water forms—the gametophyte is independent and the conspicuous phase; differentiation of structure is comparatively slight, and perhaps the majority of the members, of the liverworts especially, are moisture-loving in habit. Suppose we regard this gametophyte as the direct descendant of the thallus of an Alga bearing sex-organs, what is the relation of the sporogonium? The most probable answer is perhaps as follows. In the Green Algae generally the oöspore either germinates directly to produce a new thallus (e.g., *Vaucheria*), or it may undergo one or two divisions before doing so. In *Oedogonium* the germinating oöspore organises four zoöspores (see Figure 157)—asexual spores—each of which produces a new plant. The nucleus of the zygote of *Spirogyra* also divides into four, but three of the nuclei disappear (see Figure 158)—a kind of degenerate form of the tetrad division seen in *Oedogonium*. In *Oedogonium* it may be said that there is a short post-sexual or sporophytic phase. Suppose that this tendency is carried further, so that several successive divisions take place in the oöspore before it finally breaks up into asexual reproductive units; the structure produced is essentially a simple sporophyte.

In the simpler liverworts, such, for example, as *Riccia*, the sporophyte is formed by the oöspore undergoing repeated division until a sporogonium is produced, which consists of a wall enclosing a mass of spores—just such a type as we have imagined for our Algal type above (see Figures 159 and 162).

Passing to members of the Bryophyta which show a more complex structure for the sporogonium, we can imagine these to be derived by the conversion of originally fertile tissue into sterile, with a consequent slight delay of spore production, but with the formation of a structure better adapted for the nourishing of the developing spores, and also, finally—an important point—for their dispersal, as they are no longer self-dispersed. In this way a series showing increasing complexity of structure may be constructed from the living Bryophyta. Thus, without assuming any direct relationship among the forms, we may contrast in this way *Riccia*, *Marchantia*, *Anthoceros* of the liverworts, and *Sphagnum*, *Funaria* of the mosses, the whole forming an upward series of the type described, while there is little doubt that in evolution *Funaria* represents a higher form than *Riccia* (see Figures 160, 161, and 163).

Thus we outline the argument, which has been fully stated by Bower, * that here the sporophyte is to be regarded as an elaboration of the fertilised egg cell, and is a new structure not really developed to any extent in the Algae. This is not, however, the only theory of the sporophyte, as will be seen below.

There is no true evidence of any forms among the Algae which really approach the Bryophyta. *Coleochaete* was at one time thought to do so, but this view cannot now be held. The theory rests, therefore, very largely on the analysis of biological principles and their application to this case. There is, as has often been said, a big break in the chain of evolutionary forms which connect the moss plants with the Algae.

The other groups now engage attention. Are these descended in any way along the same line as the Bryophyta or along a totally distinct one? It may be said at once that the botanical camp is divided upon this question, the "factions" reading the meagre evidence in different ways. Although the Pteridophyta are well represented in the fossil flora, in deciding this question the evidence again seems of little use, for no really primitive fern plants have as yet been identified. The fossil forms greatly enlarge our idea of the group, but they do not extend its boundaries till they overlap with a lower one.

The two principal theories of their origin are briefly here set out.

That which will be first taken assumes that the Bryophyta and Pteridophyta are ultimately of the same or closely related origin, and the sporophytes are regarded as really of the same nature. The differentiation of this in the Pteridophyta has obviously gone very much further, but this is the result of the same general processes. The sterilisation has gone so far that a self-supporting structure, with well-organised root and shoot systems, has been produced, as, for example, in the ferns, selaginellas, and so on. In consequence, the proportion of spore-producing tissue has been relatively reduced, and the development of spores delayed to a late period, but special spore-bearing organs have been evolved—the sporangia and sporangiophores. Thus, on this theory, the so-called

* See Bower, "Origin of Land Flora."

Antithetic theory of Alternation, the gametophyte, or prothallus, is the direct representative of the Algal ancestor, and the sporophyte, as a separate leafy plant, has arisen *de novo*.

The other chief theory regards the two generations as more or less equal from the start, descending from representative generations in the Algae. The sporophyte is thus a direct representative of the asexual generation or phase of the Algae. Generally speaking, the alternation is not very regular in the Algae, and, as Klebs has shown, often depends very largely on external conditions. However, in many cases, as already stated, the sexual act is followed by a definite sequence of events—a post-sexual phase. The independence of the two generations in the Pteridophyte is sometimes regarded as evidence for this—the Homologous theory of Alternation.

This theory may be applied to the Bryophyta also, but there is no absolute need to regard the origin of alternation as the same for both groups. So far as the evidence goes, it seems to favour the Antithetic theory for the moss plants, and for those who are generally shy of calling in parallel or analogous descent, this theory seems to be most satisfactory for both groups. Nothing is said here about the highest group of all the Spermaphyta. These are almost certainly derived somehow from the Pteridophyta, but the discussion of this question merits a special treatment.

From the scanty facts at hand, and the mass of supposition necessary, no one would presume to dogmatise; and it is perhaps best, while keeping the ideas in sight, to preserve an open mind as far as possible. The true man of science has no right to be pessimistic, but it seems doubtful whether our knowledge will ever enable us to trace the real lines of descent of these. The clues to the problem may be quite lost or obscured, although we trust they are not.

# NOTES.

## ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

MELLISH'S COMET.—The following improved orbit of this comet is taken from a *Lick Observatory Bulletin*, and is known to be very near the truth:—

| | | | |
|---|---|---|---|
| Perihelion Passage, 1915, July 17·42188, Greenwich M.T. | | | |
| Arc from Note to Perihelion ... | 247° | 27′ | 51″ |
| Longitude of Node ... ... | 72 | 23 | 47 |
| Inclination ... ... ... | 54 | 39 | 30 |
| Log. of perihelion distance ... | 0·004932 | | |

The comet approaches the Earth within some thirty-six million miles about June 6th, and will be a conspicuous object in July to southern observers.

The following ephemeris for 11 p.m., Greenwich Time:—

| | R.A. | S. Dec. | Log. Distance. From Sun. | Log. Distance. From Earth. |
|---|---|---|---|---|
| | h. m. s. | ° ′ | | |
| July 3 ... | 5 44 0 | 48 27 | 0·0169 | 9·8261 |
| ,, 7 ... | 5 53 0 | 45 21 | 0·0112 | 9·8606 |
| ,, 11 ... | 5 59 0 | 42 40 | 0·0073 | 9·8921 |
| ,, 15 ... | 6 4 0 | 40 18 | 0·0054 | 9·9205 |
| Aug. 16 ... | 6 26 14 | 27 55 | 0·0539 | 0·0579 |
| Sept. 15 ... | 6 25 53 | 21 18 | 0·1513 | 0·0872 |
| Oct. 15 ... | 5 53 44 | 15 33 | 0·2465 | 0·0718 |

The comet returns to the view of English observers about the end of August, when it may still be a naked-eye object. The orbit shows a slight resemblance to that of Comet 1748 II, which was seen only on 1748, May 19th, 20th, 22nd, so that the elements are not very well known. Identity of the two comets is perhaps just possible, but not probable.

SOLAR ACTIVITY is increasing, and a large group crossed the central meridian early in April. A distinct magnetic disturbance occurred a few days later. Father Cortie at the April meeting of the Royal Astronomical Society showed that certain coronal streamers at the eclipse of last August could be explained on the assumption that they were projections of matter in conic sections from the large spot that was then in the disc. In the eclipses of 1893, 1898, 1905, 1908, he had established, with fair certainty, connection between the coronal streamers and spots. The connection in 1914 was more doubtful, but still plausible.

Professor Newall exhibited two spectro-heliograms, which vividly illustrated Spörer's law of latitude shift of the zones of solar activity. One, taken by Mr. Evershed in 1907, showed flocculi forming two closely adjacent parallel belts, one on each side of the Sun's equator. The other, taken recently by Professor Newall, showed two belts much more widely separated from each other, about solar latitude 20°.

POSSIBLE OBSCURE PATCHES IN THE HEAVENS.—Professor Turner has been making counts of the stars of various magnitudes in the published zones of the Great Astrographic Catalogue. He finds evidence of two large regions where there is a notable falling off of faint stars as compared with bright ones, suggesting some great cosmic cloud veiling the light of the more distant stars. He incidentally expressed the hope that the observatories that have as yet published little or nothing of their zones of the catalogue will endeavour to accelerate publication. It is now nearly thirty years since the scheme was initiated, but there seems small prospect of its completion before 1925. Some of the southern observatories have been hampered financially, and several changes have been made in the original assignment of the zones. A conference was to have been held in Paris this year to consider, *inter alia*, the acceleration of publication, but owing to the war this has been deferred.

THE NINTH SATELLITE OF JUPITER.—Mr. Seth Nicholson, the discoverer of this tiny orb, gives a full account of the discovery and of the orbit in *Lick Observatory Bulletin*, No. 265. A plate was exposed on the eighth satellite on July 22nd last, the telescope being driven so as to follow it accurately and give a round image, while the fixed stars appear as trails. It fortunately happened that the new satellite was in the same region, and moving at nearly the same speed among the stars, so that it registered itself as a very faint, round dot. It is clear that, if its speed had been different, it would have trailed on the plate, and its image would have been invisible. The stranger was immediately detected on the plate, this being a testimony to the extreme care with which it was examined. It needed exposures on several nights to make sure that it was really a satellite, as there are often flaws that look very like astronomical bodies. All tests were satisfied, and its character as a satellite was verified, Professor Leuschner's powerful method being used to find the orbit. The following elements were deduced: Node, 309° 23′; Omega, 71° 10′; inclination, 157° 51′; mean anomaly, 1914, July, 27·88, 49° 28′;

eccentricity, 0·163; period, 3·125 years. The motion is retrograde, as in the case of the eighth satellite. These elements are only approximate, both because the arc of observation is short, and also because the orbit differs markedly from an ellipse, owing to the great perturbations produced by the Sun. The late Dr. Hill showed that a direct satellite with five lunations to its primary's year would have its Syzygy Axis less than the Quadrature Axis in the ratio 10/11. Mr. J. Jackson (*Monthly Notices*, December, 1913) has investigated the case of retrograde motion, finding that the ratio of axes would be 16/17 in an orbit nearly the same as that of IX. Stable motion is possible at a greater distance from the primary when the motion is retrograde. The extreme distances of IX from pair. A similar relation holds between the sixth and seventh satellites, whose periods are about two hundred and fifty and two hundred and sixty days respectively.

TEMPEL'S COMET AND THE PLANET URANUS.—Professor Sampson has made an examination of Leverrier's suggestion that this comet and the Leonid meteor swarm were captured by Uranus and their period changed to thirty-three years in the year A.D. 126. So great is the weight justly attached to all Leverrier's calculated conclusions that even his unproved suggestions (like the present one) are treated in most textbooks as though they were undoubted facts. But a moment's consideration will show that such a conclusion cannot be accepted as

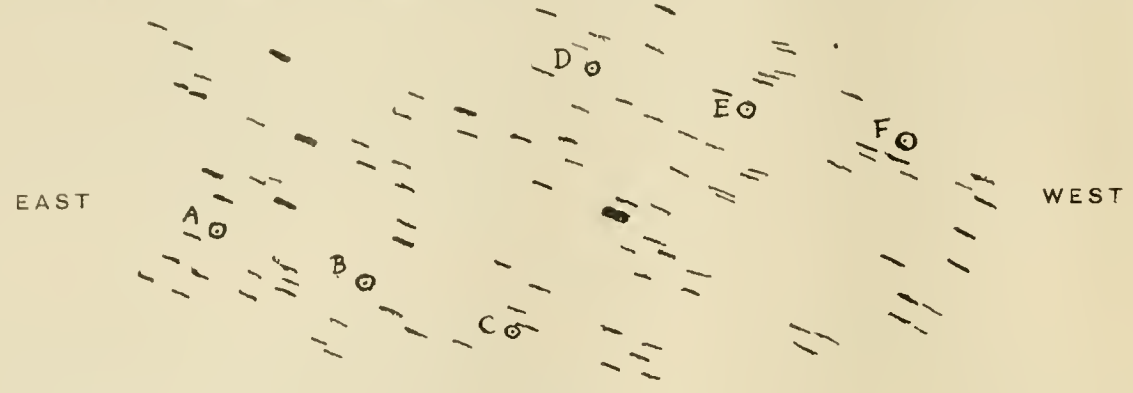



FIGURE 166.

Tracing from the plates on which Jupiter IX was discovered.

A B C are the positions of IX on 1914, July 22, 23, 24.

D E F are the positions of VIII on the same days.

The exposure on each day was about 2½ hours, so that the star-trails are about one-tenth as long as the daily motion of the satellites. It will be seen that the rates of motion of VIII and IX among the stars are very nearly the same. Consequently the images of IX are points. The rings round the satellites are merely drawn to facilitate identification.

The distance from A to C is about 12′. Jupiter was 1½° east of IX and 13′ south of it.

Jupiter are twenty-three and fourteen million miles, which are comparable to the distances between the orbits of the terrestrial planets.

VIII and IX will ultimately give a very reliable value of the mass of Jupiter, but observations covering many years will be required for this purpose.

MINOR PLANETS.—A note on these tiny planets fits in appropriately after the consideration of the small outer satellites of Jupiter. The work of search, now almost entirely done by photography, and of observing known planets, has been definitely organised and distributed. There is as yet no evidence that we are approaching the exhaustion of the zone. Last year more than sixty discoveries were announced, but a certain percentage—possibly one-third—of these will prove to have been observed before. Nearly eight hundred planets have now received permanent numbers, some fifty more have had approximate orbits calculated, while some two hundred more are known to exist, but have not been observed sufficiently for the calculation of orbits. Two long-missing planets have lately been recovered. One—99 Dike—had been missing since 1868, the year of its discovery. It was the only missing planet in the first hundred, so its recovery is a matter for congratulation. 353 Ruperto-Carola, missing since 1893, has also been rediscovered.

The Trojan group, which forms approximate equilateral triangles with the Sun and Jupiter, are being kept under observation. The theory of their motion is very interesting.

JUPITER'S NINTH SATELLITE.—A later determination of the orbit of this satellite has been published, which makes the period two years two months—very nearly the same as that of the eighth satellite. These two satellites had probably a common origin, and form a connected

certain unless we know with absolute accuracy the history of the swarm for every moment of time from A.D. 126 to the present. Such accuracy is altogether unattainable in meteoric orbits. The probable error of the Leonid radiant is about a degree. Different members of the swarm have sensibly different tracks. The perturbations calculated by Professor Adams were only mean perturbations, and might differ very considerably from the true perturbations in a period of finite length. Moreover, Professor Sampson has examined Leverrier's papers, and finds that all he did was to see that the node on Uranus' orbit was in the right position in 126; he never examined the position of the major axis of the orbit, so that he was not acting with his wonted caution and accuracy in making his suggestion of capture. Professor Sampson shows that the date A.D. 126 for the capture is most improbable, and that A.D. 885 satisfies the data much better. However, for the reasons given above, I think that any date for the occurrence should be treated merely as a more or less probable suggestion.

The late Mr. R. A. Proctor suggested that the comet families of the giant planets (with their attendant meteor swarms) were not captured by them, but were expelled from their interiors in mighty eruptions. It appears to me that this theory has been too hastily rejected by astronomers. Jupiter, the giant planet that we know the best, exhibits at times on his surface clear evidence of tremendous activity; and there is no necessity to consider the expulsion of comets as a frequent occurrence. About two births per century in the case of Jupiter, and still less in the case of the other giant planets, would suffice to balance the wastage. The objection has been made that, if the eruption lasted many hours, the rotation of the planet would cause a great dispersion of the resulting orbits. However, the total mass of comets or meteor swarms, cosmically speaking, is small;

and, if they left their parent planet in a state of close concentration, the expulsion need not last for more than a few minutes. The close concentration is required equally on the capture theory. For unless all the particles passed at practically the same distance from the capturing planet, their subsequent orbits would be very different.

## BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

TRANSPIRATION STUDIES WITH COBALT PAPER.—Among the many methods used for studying and giving off of water vapour by plants one of the best known is that in which thin blotting-paper is dipped in a solution of a cobalt salt and then dried, becoming blue when dry, but immediately changing to red when moistened. This method, with modifications so as to standardise it, has been used in making comparative tests of the transpiration of different plants, the ratio of the time required for colour change of the paper over a standard water surface to the corresponding time required for the same change when the paper is applied to the leaf of a plant giving the index of transpiring power of the given leaf surface. An important paper, giving the results of this method with a large number of plants, has recently been published by Bakke (*Journal of Ecology*, Volume II), who shows that the method is well suited to the study of the daily march of transpiring power, and gives valuable physiological and ecological results. This ratio or index remains practically constant and low during the night, but suddenly increases at about sunrise, attains a maximum for the day some time before the occurrence of the daily maximum of temperature or of evaporation, and then falls to the night value. Various plants, growing under more or less arid soil and air conditions, gave differences in transpiring power which suggest that the same species may possess quite different indices when grown under moist conditions from those shown by individuals grown under dry conditions. It appears that the magnitude of the transpiring power is probably a physiological character that will be found to vary for each species, within certain limits, just as do the morphological characters used in classification—leaf, size, shape, hairiness, and so on.

An important outcome of these studies is the conclusion that the method as employed by Bakke offers an apparently adequate and simple means for classifying plant forms in a scale of xerophytism or of mesophytism, according to the transpiring power of the leaves. The term "mesophyte" might be quantitatively defined as referring to plants with average index of foliar transpiring power between 0·7 and 1 or higher; while the term "xerophyte" may be considered as connoting plants with an index below 0·3; plants with indices between 0·3 and 0·7 would lie in an intermediate group. The author's results with alfalfa and certain grasses show that the agricultural problem of determining the relative drought resistance of different crops or different varieties should be approachable by means of this method, which appears to be by far the most satisfactory yet suggested. It is suggested also that foliar transpiring power may be a characteristic of plants, the magnitude of which may prove valuable in predicting the need of irrigation long before the occurrence of any wilting.

ORIGIN OF COAL.—This interesting question is dealt with from various points of view by White and Thiessen in a recent publication (Bulletin 38) of the United States Bureau of Mines. The authors have studied coal and peat geologically, microscopically, and chemically, and have added much information regarding the structure, rate of deposition, metamorphism, and so on, of coal. Some of their general conclusions may be given. All coal was evidently laid down in beds corresponding to the peat beds of the present day, and all kinds of plants, in whole or in part, went into the deposit. The various materials entering into plant structure differ widely in their resistance to the various agencies concerned in peat formation and subsequent coal formation. At the death of the plants there begin, depending on the conditions in the bog, partial decomposition, maceration, elimination, and chemical reduction, brought about chiefly by organic agencies, chiefly fungi at first, and later bacteria. Labile substances, like proteins, are removed first, and the more resistant next, leaving the most resistant in the residue, which we call peat. These various processes, conducted mainly by biochemical agencies, are taken up and continued by dynamochemical agencies through various later stages, resulting in the different grades of coal, as lignite, sub-bituminous, bituminous, cannel coal, and anthracite. Hence coal is composed of the most resistant components, of which resins, waxes, and higher fats, or the derivatives of the compounds of which these are composed, are the most important. These substances perform mainly protective functions in plants, as in cuticles, spore coats, bark, cork, and waxy coverings. The authors consider that algae have not played any prominent part in coal-formation, though this has been recently a somewhat conspicuous theory.

BIOLOGY OF COWSLIP FLOWERS.—Dahlgren (*Bot. Notiser*, 1914) has made a detailed study of the biology of the flower in the Cowslip, with interesting results. As to the early development of the flower, he confirms the view that the corolla arises as a series of five outgrowths from the outer side of the same structures which produce the stamens; also that the wall of the ovary arises in the form of a ring-like upgrowth in the centre of which the placenta grows up later, and quite independently. He watched the development of the flowers through the winter: the flowers are laid down in September; the pollen mother-cells are ready for division and the ovules recognisable by the beginning of December; by the end of February, while the soil was still frozen (the observations were made in Northern Sweden), the pollen was nearly ripe, but the ovules lagged behind. Some interesting data were obtained regarding the results of legitimate and illegitimate fertilisation. The author found that both kinds of pollen occurred on the stigmas of both short-styled and long-styled flowers; that a good deal of illegitimate crossing takes place; and that, apart from the difference in weight of seeds produced by the two methods pointed out by Darwin, there is, apparently, a constant difference between the seeds formed by the two forms of flowers, those from the long-styled flowers weighing on the average 0·001054 gramme, and those from short-styled flowers 0·000935 gramme. He also found that the seeds, when sown at the end of July, and kept at a temperature of only 5° to 7° C., germinated after four months; hence they do not, as stated by some writers, require a rest of two winters after being formed.

## CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE PHOSPHORESCENCE OF FLUOR-SPAR.—Certain varieties of fluor-spar emit a pale green or violet light when gently heated, while if the temperature be raised the crystals throw off luminescent particles. The cause of this phosphorescence is attributed by Dr. Formhals (*Chem. Zeit.*, 1914, XXXVIII, 1111) to the oxidation of finely divided arsenic sulphide present in traces in these varieties of fluor-spar. A specimen of felspar, which showed no sign of phosphorescence when ignited, behaved in an analogous manner after the addition of a trace of arsenic sulphide.

PHYSIOLOGICAL ACTION OF ALUMINIUM SALTS.—The effect of small quantities of aluminium salts upon the growth of plants has been investigated by Dr. Kratzmann (*Chem. Zeit*, 1914, XXXVIII, 1040). The colouring matter of red cabbage plants was changed to blue when the plants were grown in a medium containing 0·01 per cent. of

aluminium nitrate. The hydrolytic activity of certain plants was stimulated by the presence of aluminium salts, with the result that the proportion of starch was diminished. This was notably the case with *Elodea*, but not with *Spyrogyra* or *Lemna*. In other experiments the formation of starch by leaves placed in a solution of sugar in the dark was completely inhibited by the presence of one per cent. of aluminium nitrate. Minute quantities (0·0001 per cent.) of the salt had a slightly stimulative effect upon the growth of higher plants, but as little as 0·05 per cent. retarded the growth. The mould-fungus (*Aspergillus niger*) grew readily on a glycerine medium containing up to 0·1 per cent. of aluminium sulphate or chloride, but the growth stopped in the same medium without the addition of aluminium salts.

PHOTOGENIC SUBSTANCES IN THE FIRE-FLY.—Previous investigations have shown that the factors essential for the production of light by the fire-fly are the presence of water, oxygen, and a photogenic substance. In the last issue of *The Journal Amer. Chem. Soc.* (1915, XXXVII, 396) Mr. E. Newton Harvey records the results of experiments to isolate the photogenic substance. The dried material from the flies was dried in a vacuum over calcium chloride, and extracted with distilled water for fifteen minutes. Oxygen was then admitted to the apparatus, and caused the residue to show bright, glowing points, whereas the extract remained quite dark. After extraction for an hour luminescence was completely destroyed. Various other solvents were tried, but it was not found possible to extract the photogenic substance without destroying its activity. The temperature of extraction was not the cause of this destruction, for the dried powder could be heated to the boiling-point of alcohol without losing its luminescence. Cultivations of luminous bacteria behaved in an analogous manner, and showed that their photogenic substance was similarly complex and unstable. It is probable that an oxidising enzyme plays a part in the production of luminescence, although no direct oxygenase, but only small amounts of indirect enzyme (peroxidase), have been found in the fire-fly.

REPORT ON PATENT MEDICINES.—The Select Committee appointed to inquire into the sale of patent medicines have issued their report as a Parliamentary paper. In the course of the inquiry forty-two witnesses were examined, including medical men, pharmacists, analysts, and manufacturing chemists, and every aspect of the question was considered. It is pointed out that, while in the British Dominions and in foreign countries the sale of such articles is restricted by law, there is in this country no effective control, and many of the remedies put on the market are devised by ignorant people and exploited by cunning swindlers. No department of State has the power to interfere with the sale or the advertisement of proprietary articles which comply with the confusing decisions of the revenue laws, and these are numerous and remarkable. For example, duty must be made upon a remedy for a particular complaint, but not upon one which is stated to be intended for the seat of the complaint. Thus "cough mixture" is dutiable, while "chest mixture" is not; "corn-paint" contributes to the revenue, while "toe-paint" escapes. In short, "for all practical purposes British law is powerless to prevent any person from procuring any drug or making any mixture, whether potent or without any therapeutic activity whatever (so long as it does not contain a scheduled poison), advertising it as a cure for any disease or ailment, recommending it by bogus testimonials and the invented opinions and facsimile signatures of fictitious physicians, and selling it under any name he chooses, on the payment of a small stamp duty, for any price he can persuade the public to pay."

As remedies the Committee recommend the consolidation of the Stamp Acts, the removal of anomalies, and the amendment of the Indecent Advertisement Acts, together with the following special legislative enactments: (1) Compulsory statement of the proportion of alcohol in proprietary remedies; (2) Prohibition (except by a doctor's order) of the sale of medicines purporting to cure certain specified diseases, such as cancer, consumption, deafness, paralysis, and so on; (3) Prohibition of advertisements relating to sexual matters; (4) Prohibition of advertisements suggesting that a remedy is an abortifacient; (4) No change to be made in the composition without notice to the supervising department; (6) Fancy names to be subject to regulation; (7) Validity of trade names to be subject to a time-limit; (8) Any false description to be a breach of the law; (9) Various specified practices to be prohibited, such as inviting sufferers to correspond with the vendor, using fictitious testimonials, or medical testimonials without the name and address of the giver, and promises to return money if no cure is effected.

## GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

GLACIATION OF NORTH JAPAN.—There is considerable difference of opinion as to whether the mountains of North Japan have been glaciated or not. The evidence is reviewed by K. Oseki (*Scot. Geog. Mag.*, March, 1915), who comes to the conclusion that there are undoubted traces of glacial phenomena on certain peaks. Thus, on Oyama, at a height of two thousand five hundred metres, there is a corrie with two series of terminal moraines, while several other mountains likewise show moraines and corries, some of which have a fairly well-defined "step." Occasional glaciated boulders have also been found. The chief evidence against glaciation is the absence of a boreal fauna in the quaternary deposits of the district (cf. Lepsius, *Geol. Rundschau*, 1912).

CLIFF SCENERY OF CAITHNESS.—The coast of Caithness shows a remarkable variety of cliff scenery, due to the varying nature of the country rock. Thus the Muir of Ord granite forms massive cliffs, with the outlines rugged owing to the irregular jointing. Further north, the conglomerates form similar cliffs, but, in addition, sea-caves and buttresses develop along vertical joints. In the case of the sandstones and flagstones, particularly where the bedding planes are inclined at low angles to the horizontal, the coast-line assumes the form of lofty cliffs with the numerous "goes" and "cletts," which are such a characteristic feature of the scenery of the north coast of Scotland ("Geology of Caithness," 1914). The "goes" are long narrow inlets, with parallel walls, which develop along crush or weakness planes between vertical joints. At the upper end of the "goes" there is often a cave where the extension is still in progress (the erosion taking place by undermining), and a talus slope or beach where the sea has retreated. When the bedding planes are inclined at high angles, the "goes" are very irregular in form. The "cletts" are stacks or pillars which have been cut off from the cliffs by erosion and subsidence along joints. They are often as high as the cliffs, and their recent origin is shown by the presence of a cap of boulder clay, and occasionally even of peat.

## GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

SINKING OF CRYSTALS IN IGNEOUS MAGMAS.—Darwin long ago pointed out that the observed diversity in some igneous rock masses might possibly be explained by the sinking of crystals through the liquid magma as they were formed. The minerals of earliest formation are generally the most basic and the heaviest. If the sinking of crystals does take place, heavy minerals of early crystallisation, such as iron-ore, olivine, and augite, should, under suitable conditions, be concentrated toward the base of the

igneous rock masses in which they occur, and thus give rise to a rock different from that constituting the upper parts. This idea fell into disfavour as an explanation of the *differentiation* of igneous rocks, but has recently been revived and much strengthened by the description of several igneous rock occurrences in which the heavier minerals are actually concentrated towards the base of the mass. Bowen (*American Journal of Science*, February, 1915) has placed the matter upon an entirely different footing by actually demonstrating the sinking (and rising) of crystals in artificial melts corresponding in chemical composition to certain igneous rocks. Melts were prepared from which olivine began to crystallise at 1460° C. The temperature was allowed to fall to 1430°, and was maintained at this point for varying periods of time. The melt then consisted of four per cent. olivine crystals and ninety-six per cent. liquid glass. The effects of sinking were plainly visible after fifteen minutes. The small olivine crystals became more and more abundant towards the bottom of the crucible. After eighty minutes the top half of the mass was a clear glass, and all the olivine crystals were collected in a layer one and a half millimetres thick at the base of the crucible. Similar effects were obtained in melts from which pyroxenes crystallised. On the other hand, crystals of tridymite floated in the melts. The rate of sinking increased with the size and density of the crystals, and decreased as the viscosity of the melt rose. Bowen applies these results to the case of an olivine-rich layer in the diabase sill of the Palisades of the Hudson River, and estimates that in the absence of disturbance by convection currents the accumulation of the olivine crystals might have been accomplished in a period of two hundred to three hundred hours. Bowen concludes that this factor of sinking of crystals in magmas must henceforth be accepted as of fundamental importance in explaining the observed diversity in certain igneous masses.

OPHTHALMOSAURUS.—A fine skeleton of this curious reptile has recently been mounted at the Natural History Museum. A note concerning it is contributed to *The Geological Magazine* for April by Dr. C. W. Andrews. The Ophthalmosaurus is a highly specialised type of Ichthyosaur or Fish-saurian. Its enormous eye-sockets indicate eyes that were suitable for life at considerable depths in the water, and its shape shows adaptation for rapid movement. In fact, Dr. Andrews considers that Ophthalmosaurus holds amongst the reptiles the same place that the swiftly swimming toothed whales hold in the Mammalia, and that the similar mode of life in the two cases has produced somewhat similar modifications in the structure. For example, the front paddles are enlarged, the hind ones reduced in size. There is a large caudal fin; the head is elongated, with an extremely sharp snout, and with the neck very short. Another peculiarity is the great reduction in the dentition, the adult's teeth being very small and confined to the front of the jaws. The mounted skeleton is thirteen feet six inches in length, of which the head occupies three feet two inches.

## METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE WEATHER OF JUNE.—June, the first of the summer months, is usually characterised from its commencement by a considerable increase of temperature. The north-east wind of the spring months now retires before that from the westward. Vegetation proceeds most rapidly towards perfection, and the general appearance of the landscape is the most beautiful of any period of the year.

June was rather a cold month in the years 1841, 1843, 1854, 1860, 1869, 1871, 1903, and 1909. It was a very warm month in the years 1846, 1858, 1868, 1877, and 1896. The average mean temperature at Greenwich is 59°·4; in 1858 it was as high as 65°·7, while in 1909 it was as low as 53°·9. The average maximum temperature is 70°·7; the highest mean was 80°·1 in 1846, and the lowest 64°·6 in 1903. The average minimum temperature is 49°·9; the highest mean was 55°·0 in 1846, and the lowest 46°·0 in 1869. The absolute highest temperature recorded was 94°·5 on the 16th in 1858, and the absolute lowest 35°·6 on the 1st in 1869. The temperature rose to 80° or above on sixteen days in 1846 and on thirteen days in 1858.

The average rainfall for the month of June is 1·97-in.; the greatest amount was 6·07-in. in 1903, and the least 0·21-in. in 1895. The heaviest fall in one day was 1·43-in. on the 12th in 1848. The average number of "rain days" (*i.e.*, on which 0·01-in. fell) is 11·6; the greatest number of days was twenty-three in 1860, and the least three in 1887. The average number of thunderstorms is two.

The average amount of bright sunshine at the Kew Observatory, Richmond, is one hundred and ninety-three hours.

The average barometric pressure in London for June is 29·997-in.; the highest mean was 30·234-in. in 1826, and the lowest mean was 29·733-in. in 1852.

AUDIBILITY OF GUN-FIRING IN THE NORTH SEA.—In *The Quarterly Journal* of the Royal Meteorological Society for April it is stated that on Sunday, January 24th, several persons in the neighbourhood of Malvern and Hereford heard what appeared to them to be cannon reports, which they believe to have been the sound of the gun-firing in the naval engagement which was going on at the time in the North Sea.

Some correspondence also appeared in *The Times* as to the agitation of pheasants over a considerable part of the country on the same day. Canon Rawnsley, who investigated the matter, said that all his correspondents spoke of the excitement among the pheasants, their flying high up in the air and "churruking," as quite unlike ordinary excitement in a pheasant preserve on the morning of a battue. He was consequently of the opinion that the birds were really excited by the North Sea battle. Dr. C. Davison suggests that the disturbance might be caused by the sudden swaying of low trees and undergrowth during the passage of the air-waves.

The weather chart for January 24th shows that the distribution of pressure was favourable for light north-easterly winds with an overcast sky, and so the conditions were such that the sound of the gun-firing in the North Sea may have been heard to a considerable distance in a south-westerly direction. Hereford would be more than two hundred miles away.

STATE OF THE ICE IN DANISH WATERS IN FORMER AND PRESENT TIMES.—Mr. C. J. H. Speerschneider has collected all the information available between the years 690 and 1860 tending to throw light upon the question about the ice in Danish waters in former and later times. This has been published in a treatise issued by the Danish Meteorological Institute. From the information collected it appears that the following years had the hardest ice winters:—

| | | | |
|---|---|---|---|
| 1048 ... | 1460 ... | 1684 ... | 1830 |
| 1269 (?) ... | 1546 ... | 1709 ... | 1838 |
| 1296 ... | 1593 ... | 1740 ... | 1855 |
| 1306 ... | 1608 ... | 1776 ... | 1871 |
| 1323 ... | 1635 ... | 1784 ... | 1893 |
| 1408 ... | 1658 ... | 1789 | |
| 1423 ... | 1670 ... | 1799 | |

The thirteenth to the sixteenth centuries seem to have had from two to three hard ice winters per century. In the seventeenth, eighteenth, and nineteenth centuries there were about five particular ice winters per century. This difference may perhaps be explained by the larger amount of information available for the later years than for the earlier periods. After a careful consideration of all the data collected Mr. Speerschneider is of opinion that there is no reason to believe in any marked difference in the amount of ice in Danish waters during the winters of former periods and of the present day

# MICROSCOPY.

By F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundred and seventh ordinary meeting of the Quekett Microscopical Club was held at 20, Hanover Square, W., on Tuesday, April 27th. Mr. Ainslie, R.N., introduced the following paper entitled "An Addition to an Objective."

Few microscopists who have made much use of high-power dry objectives have failed to realise the connection between the tube-length and the thickness of the cover-glass if good definition is to be obtained. This is, indeed, mentioned in text-books, but not, as a rule, at any very great length. For instance, little is said as to the amount of alteration required in any given case. The sensitiveness of objectives varies enormously: it varies with the formula on which the objective is constructed, but more especially with the power of the objective. As an example, half-inches of high aperture, such as the Holos and Zeiss apochromat, require only a change of one or two millimetres in the tube-length to compensate for a variation of ·01 millimetre in the thickness of the cover-glass; for a one-sixth the figure is from nine to thirteen millimetres; while for a one-eighth, such as the Leitz No. 7, the figure is as much as twenty or twenty-one millimetres. Water-immersions are also subject to this sensitiveness, though to a smaller extent, the figure in the case of a Zeiss "G" being 9·2 millimetres.

This difficulty is more serious than is generally realised, and is enhanced by the extremely small range of draw-tube in the average Continental stand and, unfortunately, in many stands of English make. The present paper is an attempt to find a way out of this difficulty, due to the range of the draw-tube being in many cases insufficient for the proper examination of specimens with cover-glasses of abnormal thickness or thinness, especially with the higher powers.

Many years ago the celebrated Van Heurck used what he called a "transformer" as a means of making a long-tube objective work on a short tube, and *vice versa*. This consisted of a convex or concave lens of low power, fitted above the objective, which, it will be readily understood, affords a means of altering the actual plane in which the image is formed, without affecting the action of the objective, should the cover be of such thickness as to require, for the proper working of the objective, a tube-length which would bring the image beyond the limits of the draw-tube.

With the high-power dry objectives in most common use, such as a one-sixth, the power of the additional lens required to effect the compensation for a very great change of cover-thickness is not great, a pair of lenses—convex and concave—of about three diopters power, or about thirteen inches focus, being sufficient to correct for a very considerable range of cover-thickness; but with higher powers, such as eighths, the amount of correction which can be got in this way is a good deal less, as might be expected from their much greater sensitiveness. As an example of what can be done with an objective of not too high power, it may be said that a Watson one-sixth, of N.A. ·74, which is normally correct for a cover ·18 millimetre thick, and a tube-length of two hundred millimetres, can be made to work well through a cover-glass as much as ·5 millimetre thick, if a concave lens of —8 diopters be placed behind it; while with a convex lens of the same, or somewhat lower, power it will work well on an uncovered object; and many other objectives of this power will do as well.

I have so far experimented only with simple lenses, but the chromatic and spherical corrections are not perceptibly affected unless the power of the additional lens is as great as ten diopters, and even then the effect is not serious, and is not appreciable at the centre of the field.

The power of the objectives is somewhat reduced by the convex lens, as well as the N.A.; while with the concave lens the effect is the opposite; but the change is not great if the additional lens be placed as near to the back lens of the objective as possible, though, for reasons of convenience, it does very well to put it in the rear of the mount.

If for the oil in which an oil-immersion objective is immersed we substitute water, the effect is the same in kind (though greater in degree) as the effect of a thinner cover-glass in the case of a dry objective; and it is possible to convert an oil-immersion into a very good water-immersion by merely fitting behind it a convex lens of suitable power. The power cannot be predicted, but must be determined experimentally for each objective. Here, again, it is easier to effect the conversion in the case of an oil-immersion of moderate power, such as a one-tenth, than in the case of a one-twelfth or higher power, though a one-twelfth can be dealt with very satisfactorily. A Watson "Parachromatic," for example, requires a convex lens of ten diopters, and it is important in the case of oil-immersions of this power to place the additional lens as close as possible to the back lens of the objective, to avoid too great reduction of the working distance, which is to a certain extent unavoidable.

With an oil-immersion thus converted into a water-immersion, it is useless to expect that the whole aperture will be available; the corrections of the objective are too much upset for that; but, if the additional lens is made of such diameter as to reduce the N.A. to about 1·1, and an illuminating cone of not more than about ·75 or ·80 N.A. used, the performance is, in all cases tried, quite up to the standard of the ordinary water-immersion, and better than some. The additional lens may very conveniently be fitted to the "funnel stop" usually supplied with oil-immersions for the purpose of reducing the aperture for dark-ground illumination, taking the place of the stop. In this way it can be brought close to the back lens, and the working distance is not reduced more than is necessary and unavoidable.

It is believed that this method of converting an oil-immersion into a water-immersion has not been previously described; it is hoped that it may be of use to those who occasionally require to use water-immersions in work on living specimens, or in other work for which an oil-immersion would be inconvenient.

The Honorary Secretary, Mr. J. Burton, then read "Notes on Diatom Structure," by Mr. A. A. C. Eliot Merlin, F.R.M.S. He drew attention to a very beautiful form of tertiary structure he recently found on a variety of *Aulacodiscus comberi* from Oamaru. The valve is on a styrax-type slide of two hundred and thirty forms from that locality, and is covered with a network of dark, well-defined secondaries, except on the parts occupied by the large primaries. Each of the dark secondaries splits up into three or four parts by a bright cross-bar arrangement. This structure requires a good oil-immersion objective and a very considerable magnification to render it readily discernible; but it is not a glimpse object, and when well seen reminds one of the bridges of bright matter that are frequently observable crossing the umbrae of sunspots.

A photograph of the above was exhibited, and Mr. E. M. Nelson, F.R.M.S., confirmed the presence of this structure from a specimen in his cabinet.

Mr. Merlin also exhibited two other photographs of a diatom. Mr. Nelson had written to him that he had discovered that *Coscinodiscus simbirskii*, which with ordinary transmitted light resembled *Coscinodiscus asteromphalus*, when examined with dark ground and a rather small stop looks like *Actinoptychus splendens*. This led him to search for the diatom specified; and, although this could not be found, he found one which, with dark-ground illumination, revealed a beautiful radiating structure, somewhat resembling a Heliopelta, which was not observable by transmitted light. On the photographs of this specimen being examined, it was identified by Mr. Morland as *Janischia antigua* Grunow.

Mr. Merlin further pointed out that, although "diatom dotting" has influenced the development of the microscope towards perfection more than anything else, he is unable to find out particulars of its introduction.

Mr. Nelson quoted an extract from Messrs. Sollitt and Harrison's paper, read before the British Association at Hull in 1853.

"We in Hull first discovered the delicate marking on their silicious coverings, and pointed them out to others as the proper tests for lenses. The first of the Diatomaceae on which the lines were seen was the *Navicula hippocampus* of Ehrenberg. . . . This was early in 1841, when specimens were sent to the Microscopical Society of London. . . . Also to Mr. Smith, Mr. Ross, Messrs. Powell & Lealand, M. Nachet in Paris, and Professor Bailey in America, all of whom at once saw the excellence of these objects as tests for the microscope."

The next conversational meeting for the exhibition of objects and for discussion will be held on Tuesday, June 8th, at seven p.m., and the five hundred and ninth ordinary meeting on Tuesday, June 22nd, at eight p.m., both at 20, Hanover Square, W. Gentlemen wishing to attend either of these meetings as visitors are invited to apply for cards of admission to the Hon. Secretary, Mr. J. Burton, 8, Somali Road, West Hampstead, N.W., or to any of the leading opticians.

## PHOTOGRAPHY.

By EDGAR SENIOR.

POTASSIUM METABISULPHITE.—Of all the combinations of sulphurous acid with alkalies, that prepared by treating potassium carbonate with the acid until the quantity of the latter corresponds to the bisulphate, when the substance known by the name of metabisulphite is deposited in the form of fine crystals containing no water of crystallisation, appears to be the best so far as keeping properties are concerned. Potassium metabisulphite ($K_2S_2O_5$) is an acid salt, and contains a very much larger quantity of sulphurous acid than sodium sulphite, and keeps much better in the solid state than the latter; moreover, having no water of crystallisation, its composition is not rendered uncertain. The quantity (theoretically) of sulphurous acid is 57·65 per cent., and a sample kept for two years in a corked bottle was found on analysis to contain 55·05 per cent. of acid (Namias). Metabisulphite, being acid, is, like most acids, a good preservative of pyrogallol in solution, and may be employed in developing solutions by using about one-third the quantity that would be required were sodium sulphite used instead. As the acidity of the substance neutralises a part of the alkali added to the developer, this must be taken into account, as a portion of the alkali would thus be rendered inoperative. It might be thought that all that was necessary would be to add a further quantity of alkali, such as soda carbonate, to make up for that lost; but in most cases such a course is not to be recommended, since the carbonic acid which is set free would give rise to the formation of bicarbonate of soda, and this retards the action of the developer, especially in the case of hydroquinone. On this account the acidity of the metabisulphite should be neutralised with a little caustic soda or potash before the alkali required for development is added. In the case of developers, however, such as metol or edinol, which are more energetic in their action, it is unnecessary to use caustic alkali, as a slight increase in the quantity of alkaline carbonate suffices. Although metabisulphite keeps so well in the dry condition, it does not do so in solution, unless the bottle is full and well corked, when the sulphurous acid liberated appears to protect the surface of the liquid from direct contact with air, and under such conditions the solution will keep better than sulphite does; otherwise there is little difference in the keeping properties of either. The other bisulphite, sodium bisulphite, contains (theoretically) a little more sulphurous acid than potassium metabisulphite; but as it is much less stable, losing its excess of sulphurous acid much more readily than the metabisulphite does, it usually contains less, and at the same time has a tendency to become converted into the anhydrous sulphite having the properties already mentioned.

SULPHITES AND METABISULPHITES.—The extensive use that is made of sulphites and metabisulphites in photography suggests the question of their relative merits and stability. The sulphite that is most commonly employed in photographic work is the crystallised sodium sulphite, which is represented by the formula $Na_2SO_3 . 7H_2O$. By exposure to air, either in the solid form or in solution, oxygen is absorbed and sodium sulphate is formed; in fact, it appears impossible to obtain soldium sulphite absolutely pure, as analysis has shown that the purest sample did not contain more than ninety per cent. of sulphite, while it averaged from sixty to seventy per cent. in good samples, and in the case of inferior ones from ten to thirty per cent. (Namias). In the case of the anhydrous sodium sulphite the quantity of sulphate present always appears to be considerable, a result brought about in all probability by the process of heating employed to remove the water of crystallisation. Some samples of the anhydrous salt contain only about fifty-five per cent. of sodium sulphite. Inferior samples of sodium sulphite may also contain sodium carbonate as an impurity, as the sulphites are prepared by saturating solutions of the carbonate with sulphurous acid. In order to test for the presence of carbonate of soda in a sulphite, the gaseous mixture of $CO_2$ and $SO_2$, obtained by the action of dilute sulphuric on hydrochloric acid, may be first passed into a solution of bichromate on a cupric or ferric salt, and, finally, through lime or baryta-water. The indicator known as phenol-phthalein may also be employed, as this reăgent is turned red when added to the solution of sulphite if the carbonate is present. The presence of sulphate is shown by the addition of barium chloride to an acidulated solution of the sulphite, a precipitate of barium sulphate being formed. This reăction may therefore be made use of as a means for estimating the quantity of sulphate present in a given quantity of sulphite. It will now be readily seen from what has been stated that in making up solutions containing sodium sulphite the actual quantity of the sulphite present may be very considerably less than the weight of salt taken as such leads us to suppose, while there may be a great deal of sulphate, a body which is not only undesirable, but in many cases harmful. While the anhydrous sodium sulphite from its powdered form is more convenient, it is not to be recommended in practice, as it readily absorbs water, when the heat of hydration facilitates its oxidation, the minute grains of the anhydrous salt exposing a far greater extent of surface to be acted upon, weight for weight, than is the case with the crystallised substance. Thus crystallised sodium sulphite does not require such careful preservation from contact with the air as the anhydrous salt does. One of the simplest ways to keep sodium sulphite in the solid state is to preserve it in bottles from which the air has been displaced by means of a stream of ordinary house gas obtained from a burner. As for sodium sulphite in a state of solution, it appears to be far less stable than in the solid condition; hence keeping it in this condition is not advisable.

## PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

THE DISCOVERER OF INVAR.—*Science* announces that the city of Philadelphia, acting on the recommendation of the Franklin Institute, Philadelphia, Pa., has awarded the John Scott legacy medal and premium to Dr. Charles Edward Guillaume, of Sèvres, France, for his alloy invar. This alloy, which is approximately a thirty-six per cent. nickel steel, is remarkable for its small rate of change of size with alteration of temperature. Some specimens have been prepared with a temperature coëfficient sensibly zero, while others have very small coëfficients, which may be either positive or negative. The use of this alloy in clock-making has enabled attention to be paid to small corrections which had previously been swamped by the outlying irregularities left uncorrected in the older methods of temperature compensation. In the measurement of the

base lines for triangulation work in surveying, invar tapes are now largely employed. This has led to increased accuracy, and has notably decreased the time required in carrying out such work. Invar standards are also employed in accurate laboratory work, while the alloy has been used to some extent in electric lighting in connection with the seals of lamps.

ELECTRO-MAGNETIC INERTIA AND ATOMIC WEIGHT.—On February 26th, 1915, Professor Nicholson read a paper with the above title before the Physical Society of London. He subjected to mathematical analysis the view that the mass of an atom is of electro-magnetic origin. On this theory the sum of the masses of two charged particles is a function of their distance apart and of the velocities of the particles. The added mass due to the mutual action of the particles Professor Nicholson terms the mutual mass, and he calculated that this is proportional to the product of the charges, and inversely proportional to their distance apart when they move along the line joining them with equal velocities, small when compared with the velocity of light.

These considerations are of primary importance in the theory of the constitution of the atom. When, for instance, an atom parts with a charged atom of helium in a radio-active change, on this view the change in mass is not merely that due to the separate mass of the helium atom, but the loss of mutual mass is also to be taken into account. It should be noted that, unlike ordinary mass, this mutual electro-magnetic mass may be either positive or negative, depending on whether the charges are alike or dissimilar.

THE ELECTRIFICATION OF SURFACES AS AFFECTED BY HEAT.—Dr. P. E. Shaw has recently communicated to the Physical Society of London the results of some interesting experiments on the effect of heat in changing the sign of the electrification of surfaces. Ordinarily, when smooth glass is rubbed with silk, the glass becomes charged positively and the silk negatively. If the glass be passed to and fro in a flame for a few seconds the sign of the effects is reversed. If the glass be subjected to long-continued rubbing with silk or cotton it returns to its normal state ; while the abnormality is readily removed by passing the rod of glass through the hand or a sheet of indiarubber. Shaw found that this abnormal effect can be produced with all the common hard solids. The kind of flame used is of no moment, and the effects can be produced by heating in an electric furnace ; the glass having been rendered anomalous in its behaviour remains so, if left alone, for an indefinitely long time. The condition is not removed by washing with water. Subjection to intense cold—as, for instance, that due to liquid air—has no influence on fused silica, glass, brass, or sealing wax, whether these were in their normal or abnormal state. We hope that these and other researches on frictional electricity will be continued, and that the reproach that modern science knows little more of the origin of frictional electrification than the ancients will soon be removed.

THE NATURE OF THE ULTIMATE MAGNETIC PARTICLE.—In a letter to *Science*, April 23rd, 1915, Compton and Trousdale give an account of the results of an investigation undertaken with a view to settling this question. The ferromagnetic crystals, magnetite and haematite, were examined by *x*-ray photographs taken through the crystals while magnetised and unmagnetised. The resulting diagrams indicate that the atoms do not leave their positions of equilibrium during magnetisation. According to the authors, these results show that magnetism cannot be a molecular phenomenon.

So far as these results go, they certainly appear decisive. In the case of iron, nickel, and cobalt, and the Heusler alloys, the view that the phenomenon is molecular seems still unassailed. In the case, for instance, of an alloy made up of copper, manganese, and aluminium (all sensibly non-magnetic metals), it is difficult to attribute the notably magnetic character of the alloy to any other cause than to the formation of magnetic molecules.

PROFESSOR W. GRYLLS ADAMS, F.R.S.—By the death of Professor Adams (recorded in *Nature*, April 22nd, 1915, to which we are indebted for the following particulars), which occurred on April 10th, 1915, at the age of seventy-nine, physics has been deprived of a versatile man of science. He succeeded Clerk Maxwell in the Chair of Physics at King's College, London, fifty years ago. It was ten years later that he introduced his now well-known experimental method of investigating the equipotential lines which result when electric currents are passed through sheets of tinfoil by exploring the surface with a pair of needles connected with a galvanometer. In the same year he read a paper before the Royal Society on the change of resistance produced by magnetism in iron and steel.

Adams took up the subject of the fall of the electrical resistance of selenium on illumination soon after the discovery of the effect by Mayhew, and proved that it was not a secondary result due to heat ; he also showed that the yellow-green were most effective rays. The physical optics of crystals, terrestrial magnetism, lighthouse illumination, and electric lighting were some other of the subjects to which he contributed.

## RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

ABSORPTION OF HOMOGENEOUS $\beta$ RAYS.—In considering the absorption of $\alpha$ and $\beta$ rays by matter the general idea is that the two types of rays are very different in their behaviour in this respect. The ionising power of an $\alpha$ ray, after traversing a quantity of matter, increases somewhat, and then suddenly falls to zero. The distance in air through which the $\alpha$ ray must travel before this quick fall takes place is called the " range." Radiation from one source of $\beta$ rays is, however, absorbed exponentially. Such radiation is not homogeneous, but consists, as is proved by deviating a pencil of $\beta$ rays by a magnetic field to produce a " magnetic spectrum," of a collection of $\beta$ rays travelling with various speeds. R. W. Varder contributes a paper to the May *Philosophical Magazine*, where he describes experiments in which he separated a pencil of $\beta$ rays by means of a magnet into its component parts of homogeneous rays. By altering the strength of the magnetic field he could make any set of such rays fall on a given mica window. After the rays had penetrated through the window, various thicknesses of aluminium were interposed in their path, and so an absorption curve was found for an homogeneous pencil of $\beta$ rays. A linear relation between the ionisation and the thickness of the aluminium was obtained, and by producing this straight line until it cut the axis we get the thickness of aluminium, after which $\beta$ rays of a particular velocity cease to ionise. By analogy to the range of the $\alpha$ rays this distance is termed the " range of the $\beta$ rays." The difference in behaviour of these two types of rays is therefore not so great as is often imagined.

THE SPECTRUM OF LEAD OF RADIO-ACTIVE ORIGIN.—The difference from the normal of the atomic weight of lead of radio-active origin has been mentioned in recent months in these columns. T. R. Merton, in a recent paper published in the *Proceedings of the Royal Society*, has supplemented these experiments by comparing the spectrum of ordinary lead with that derived from the radio-active mineral, pitchblende. Lead from this source has been shown to have an atomic weight of 206 in place of the normal value of 207. In agreement with the prevailing theory of isotopes, Merton found that the two spectra of the different leads were in every way identical. If there is any difference in wave-length, it may be concluded that such difference is not greater than 0·03 of an Ångström unit.

The Chemical Society have resumed the publication of abstracts from German scientific literature, and the following notes are based on some of these appearing in the April number of the *Journal of the Chemical Society*.

RADIATION FROM THORIUM-X.—In a paper published in 1912 Hahn and Meitner brought forward evidence to show that thorium-X gives off soft $\beta$ radiation, as well as the $\alpha$ rays necessary for the formation of thorium emanation. Baeyer, Hahn, and Meitner (*Physikalische Zeitschrift*, 1915, page 6) now state that these rays are not due to thorium-X as hitherto supposed, but proceed from radio-thorium.

RADIUM-II.—In the same number of that journal Meitner also disproves the existence of this hypothetical element which Fajans and Towara alleged to have discovered (see "KNOWLEDGE," Radio-activity Notes, April, 1915).

THE QUESTION OF ISOTOPIC ELEMENTS (Hevesy and Paneth, *Monatshefte für Chemie*, 1915, page 75).—These authors have added to the already long list of studies of the electro-chemistry of the radio-elements made by them. In this communication the decomposition potential of solutions of radium-E and thorium-B has been studied. Further experiments were made in which a quantity of radium-D was grown from a very large amount of radium emanation, decaying in a closed vessel, and the radium-D was deposited as peroxide on a platinum wire. The film obtained was visible, and it was found that electrochemically its behaviour was identical in all respects with a similar film of ordinary lead peroxide. Thus no evidence was obtained that isotopic elements were at all capable of separation from one another by chemical means after they had been mixed together in solution.

## ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

NEW APODOUS FISH.—Professor Louis Roule describes from the Atlantic abysses (nine hundred and fifty metres) to the north of Fayal a new eel-like fish, which he names *Pseudophichthys latidorsalis*. It has its counterpart in *Promyllantor* from the Indian Ocean, and in the interesting *Nemichthys scolopaceus* from the Mediterranean. Most of these apodous forms are abyssal in their earliest stages and in adult life, but there may be a more or less prolonged bathypelagic larval period, and even a littoral phase. In the eels, as is well known, the littoral phase is followed by a long-drawn-out period of growth in fresh water.

MISDIRECTED INDUSTRY.—A large volume lies before us, "Histoire de l'Involution Naturelle" (Paris and Lugano, 1915), in which Dr. Henri Marconi, of Terni, seeks to show that we have all been looking at evolution the wrong way round. The process has been from the complex to the simple, not from the simple to the complex; from man to amoeba, not from amoeba to man. Everyone admits occasional retrogressive evolution or degeneration, as in parasitism, but the author's wholesale topsy-turvy interpretation, which has been tried before, will not work at all. But the attempt to make it work extends over five hundred finely printed pages.

RINGS ON OYSTER SHELLS.—It is supposed by many that the age of an oyster can be ascertained by counting the rings, or groups of rings, on its deep valve, each group being regarded as a year's growth. Miss Anne L. Massy has tested this in reference to specimens from the oyster station at Ardfry, at the head of Galway Bay; but she does not recommend the method. "All I can honestly say I have learnt from a patient scrutiny of over six hundred samples of various ages, from eighteen months to six years, is that an oyster of eighteen months or two summers appears to possess at least two rings, but may have as many as five. One of three summers has at least two rings, and may have six. A four-year-old oyster may have only three rings, or may possess seven or eight."

CLASSIFICATION OF THE SENSES.—In his very interesting experiments on the senses of fishes, Professor G. H. Parker points out that chemical stimulation affects the olfactory organs, certain nerve-endings in the skin, and the taste-buds in the mouth. He regards the olfactory sense as first in this series and taste as last. The "common chemical sense"—possessed by most aquatic vertebrates—comes in between. These three senses overlap one another and differ in degree rather than in kind. Similarly, oscillations and vibrations in the water are perceived by the skin, by the lateral line system, and by the ear, and the hearing of a vibrating tuning-fork by the ear differs in degree rather than in kind from the perception of oscillations in the water, due to some big jar or to the movements of an enemy.

ADAPTATION IN STOMACH OF OPEN-BILL.—The Indian Open-bill (*Anastomus oscitans*), belonging to the stork family, is said to live on shellfish, and Dr. P. Chalmers Mitchell has discovered an interesting adaptation in its stomach. There is a soft-walled glandular proventriculus and a hard-walled muscular gizzard with stones, and the latter communicates by a wide aperture with a small cardiac chamber which leads into the duodenum. The wall of the gizzard is raised in a strong crescentic fold, which blocks the aperture into the cardiac chamber, the free margin of the fold being frayed into flat plates placed like the teeth of a comb. The fold and plates are covered with the hardened secretion lining the general cavity of the gizzard, and particles of food can reach the intestine only after being squeezed through these plates.

CORALS AT GREAT DEPTHS.—The collections made by the Prince of Monaco have increased our knowledge of Madrepore corals from great depths. Many have been dredged from four to five thousand metres, and some particular kinds seem able to thrive at depths varying from forty metres to three thousand. Dr. Ch. Gravier calls attention to some interesting points. Some of the specimens obtained seemed to have been growing freely in the ooze without any stable substratum. The flesh of most of the abyssal forms was rusty brown or black. The food must be found, for the most part, in the rain of minute dead organisms and particles of organic débris. Gravier found some fragments of Crustaceans and Ophiuroids in the cavity of *Stephanotrochus nobilis*, which points to a utilisation of other deep-sea animals. Most of the abyssal corals are solitary, and a single cup may attain a diameter of eight centimetres. Curious associations of species are very common, but the meaning of this companionship is quite unknown.

SOCIAL LIFE OF ADÉLIE PENGUINS.—We have already called attention to Dr. Levick's fine study of the social life of the Adélie Penguins at Cape Adare (Heinemann, London, 1914). A more formal statement of his results has recently been published by the British Museum in the "Report on the Zoölogy of the 'Terra Nova' Expedition," and it is a masterpiece of observational natural history which should not be missed by anyone interested in the bio-psychological problems of bird life. What are we to think of the long journey of these flightless birds—seeing such a little way ahead!—across the trackless sea, of the quaint courtship, of the bloody (by your leave) but never fatal fights, of the stealing of stones for nests, of the cock's eye for colour, of the long fast—it may be a lunar month—of the parental coöperation, of the chicks' rapidity of growth, of the weary climbs with bellyfuls of Euphausia and often love's labour lost at the last minute, of the games and plays on the sea-ice, of the mysterious "drilling," of the autumnal migration, and of the long, long way to the vaguely known winter quarters in the ice-pack?

# SOLAR DISTURBANCES DURING APRIL, 1915.

By FRANK C. DENNETT.

THE SUN was under observation every day during April, and spots were always visible, with the exception of the 17th, when only faculae were present. The longitude of the central meridian was 345° 30′ at noon on April 1st.

Nos. 34, 35, and 37 of the March list continued visible until April 2nd, 4th, and 11th respectively, and therefore reappear upon the present chart.

No. 39.—First seen on April 2nd as a group of pores, the largest leading, about two days round the limb. The leader increased to eleven thousand miles in diameter, and its appearance, as also the disposition of the pores, was subject to constant alteration. The length of the group was seventy thousand miles, and it was last seen close to the limb on the 12th.

No. 40.—Seen close to the limb as a spot on the 2nd. Pores extended away behind for fifty-five thousand miles on the 4th, but increased to ninety-eight thousand miles. The leader also increased in size to fifteen thousand miles; then broke up into smaller spots Last seen at the limb on the 13th.

No. 41.—A pore in a bed of faculae, only seen on the 10th.

No. 42.—A pair of pores, forty thousand miles apart, in the south-eastern quadrant, two or three days from the limb; seen on the 12th and the 13th. The place was marked by faculae on the 10th, 21st, and 22nd.

No. 43.—A group of pores in northern latitude, near the central meridian, twenty-two thousand miles in length, visible from the 13th until the 15th.

No. 44.—Two spotlets, some thirty-four thousand miles apart, had broken out in a faculic bed near the south-western limb on the 15th, one remaining visible until the next day.

No. 45.—A pore, only seen on the 18th, in north latitude, some 17° past the central meridian.

No. 46.—First seen as a pore on the 18th, but on the 19th as a group of five. On the 21st two small spots with six pores between them. From the 22nd until the 24th the trailer was only a pore. The greatest length of the group was fifty-two thousand miles, and the leader was last seen on the 27th.

No. 46*a*.—A small spot with pores, south-west of the last, first seen on the 20th. On the 21st two spots with pores between. The trailer afterwards broke up into pores, but the leader increased to fifteen thousand miles in diameter, the group being sixty-four thousand miles in length. On the 26th only one pore seen behind the leader, and on the 27th and the 28th the spot was seen alone; on the later day very close to the limb.

No. 46*b*.—A spotlet and pore only seen on the 22nd.

No. 47.—A solitary pore in the north-western quadrant, only seen on the 19th.

No. 48.—A pore in a faculic area in the south-eastern quadrant, seen on the 19th and the 20th.

No. 49.—A pore, only seen on the 21st.

No. 50.—A spot with two small companions appeared close to the south-eastern limb on the 26th. The spot became thirteen thousand miles in diameter, and on the 28th and the 29th its penumbra was blotted out by photospheric matter on the preceding side. On May 2nd its umbra was become double, and on the 6th a bright bridge cut the spot into two. It was last seen at the limb on the 8th. The pores following it were subject to constant change, a conspicuous one showed some 8° south-east on April 28th, the distance increasing to seventy-seven thousand miles. This last remained visible until the morning of May 6th, none others being seen after the 2nd.

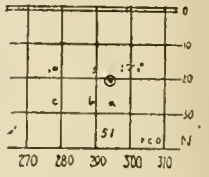


FIGURE 167.

No. 51 (see Figure 167) is a return of the great group No. 37. The large spot was first seen on the 26th. The remaining portions of the group became more clearly visible as they advanced farther on the disc. The large spot dwindled as it crossed the disc, its diameter was some eighteen thousand miles across, and it was last seen on May 8th. The group of pores west of the large spot were all gone after May 5th. On the 2nd and the 3rd a group of pores was seen directly south of the large spot. Spotlets a little south-east of the large spot, seen first on April 27th, remained visible, but much altered, until May 5th. The trailer group, first seen on April 28th, was protean in appearance, but continued visible until May 6th. This group of groups had a length of one hundred and seventy thousand miles. To prevent confusion a small chart of this group is given.

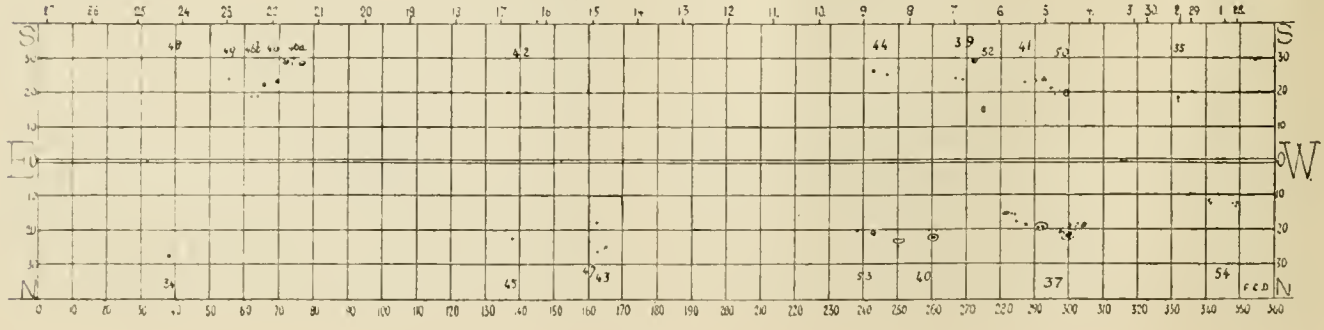
No. 52.—A spot first seen on April 28th, with a diameter of nine thousand miles. It was last seen as a pore, nearing the limb, on May 9th. Possibly a return of No. 39.

No. 53.—A spot ten thousand miles in diameter, with a small attendant on April 30th. It was a small group until May 4th; afterwards a spotlet with a pore fifty thousand miles in its rear. From the 8th until the 10th, when it was last seen, the spotlet was solitary.

No. 54.—A group of five pores sixty-three thousand miles in length, only seen on April 30th.

Our chart is constructed from the joint observations of Messrs. J. McHarg, E. E. Peacock, W. J. Waters, R. Marchment, and F. C. Dennett.

## DAY OF APRIL, 1915.



# THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 29.

| Date. | Sun. R.A. | Sun. Dec. | Moon. R.A. | Moon. Dec. | Mercury. R.A. | Mercury. Dec. | Venus. R.A. | Venus. Dec. | Mars. R.A. | Mars. Dec. | Jupiter. R.A. | Jupiter. Dec. | Uranus. R.A. | Uranus. Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenwich Noon. | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° |
| July 5 | 6 53·8 | N.22·9 | 1 31·0 | N.14·7 | 6 2·6 | N.18·8 | 5 32·4 | N.22·8 | 3 49·4 | N.19·6 | 23 55·4 | S. 1·9 | 21 10·4 | S.17·0 |
| ,, 10 | 7 14·3 | 22·4 | 5 42·1 | N.27·5 | 6 1·7 | 19·2 | 5 58·8 | 23·2 | 4 4·0 | 20·4 | 23 56·2 | 1·9 | 21 9·7 | 17·1 |
| ,, 15 | 7 34·7 | 21·7 | 9 58·1 | N.11·4 | 6 10·0 | 20·1 | 6 25·3 | 23·2 | 4 18·7 | 21·1 | 23 56·6 | 1·8 | 21 9·0 | 17·1 |
| ,, 20 | 7 54·9 | 20·8 | 14 2·8 | S. 17·9 | 6 27·8 | 21·1 | 6 51·9 | 23·0 | 4 33·4 | 21·7 | 23 56·7 | 1·9 | 21 8·3 | 17·2 |
| ,, 25 | 8 14·8 | 19·8 | 19 18·5 | S. 24·9 | 6 54·8 | 21·9 | 7 18·4 | 22·8 | 4 48·0 | 22·3 | 23 56·5 | 1·9 | 21 7·5 | 17·3 |
| ,, 30 | 8 34·5 | N.18·7 | 23 44·5 | N. 2·0 | 7 30·0 | N.22·0 | 7 44·7 | N.21·8 | 5 2·6 | N.22·7 | 23 56·1 | S. 2·0 | 21 6·7 | S.17·3 |

TABLE 30.

| Date. | Greenwich Noon. Sun. P | Sun. B | Sun. L | Moon. P | Greenwich Midnight. Mars. | Mars. B | Mars. P | Mars. L | Mars. T | Jupiter. | Jupiter. P | Jupiter. B | Jupiter. $L_1$ | Jupiter. $L_2$ | Jupiter. $T_1$ | Jupiter. $T_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° | ° | ° | ° | | ° | ° | ° | h. m. | | ° | ° | ° | ° | h. m. | h. m. |
| July 5 .. | − 1·1 | +3·4 | 169·3 | −20·1 | July 1 .. | −36·0 | −11·3 | 109·5 | 4 30 *e* | July 3 .. | −25·5 | +2·1 | 353·7 | 11·1 | 2 19 *e* | 11 41 *e* |
| ,, 10 | + 1·2 | 3·9 | 103·1 | − 0·2 | ,, 7 .. | 35·2 | 9·7 | 50·8 | 8 31 *e* | ,, 10 .. | 25·5 | 2·1 | 19·3 | 343·2 | 1 37 *e* | 2 31 *e* |
| ,, 15 .. | 3·4 | 4·4 | 37·0 | +19·7 | ,, 13 .. | 34·3 | 8·1 | 352·3 | — | ,, 17 . | 25·5 | 2·2 | 45·0 | 315·5 | 0 55 *e* | 3 17 *e* |
| ,, 20 .. | 5·6 | 4·9 | 330·8 | +18·2 | ,, 19 .. | 33·2 | 6·3 | 293·8 | 3 52 *m* | ,, 24 .. | 25·5 | 2·2 | 70·8 | 287·9 | 0 13 *e* | 4 3 *e* |
| ,, 25 .. | 7·8 | 5·3 | 264·6 | − 9·2 | ,, 25 .. | 31·9 | 4·8 | 235·5 | 7 52 *m* | ,, 31 . | −25·5 | +2·2 | 96·8 | 260·5 | 9 21 *e* | 4 48 *e* |
| ,, 30 .. | + 9·9 | +5·7 | 198·5 | −22·4 | ,, 31 . | −30·5 | −3·2 | 177·1 | 11 52 *m* | | | | | | | |

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to $T_1$ $T_2$ multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively. In the case of Mars apply multiples of $24^h\ 40^m$.

The data for the Moon and Planets in the Second Table are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced to move Southward. Its semi-diameter increases from 15′ 45″ to 15′ 47″. It is at its greatest distance from the Earth at $10^h e$ on 5th. Sunrise changes from $3^h\ 48^m$ to $4^h\ 23^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$. The Sun's surface is likely to repay careful scrutiny, owing to the recrudescence of activity.

MERCURY is a morning star. West Elongation, 20° from Sun, on 19th. Semi-diameter diminishes from 6″ to 3″. Illumination increases from Zero to ¾″.

VENUS is a morning star. Illumination almost Full. Semi-diameter diminishes from 5¼″ to 5″. Venus is 38′ North of Saturn on 17th at $1^h e$.

THE MOON.—Last quarter $4^d\ 5^h\ 54^m\ m$. New $12^d\ 9^h\ 31^m\ m$. First quarter $19^d\ 9^h\ 9^m\ e$. Full $26^d\ 0^h\ 11^m\ e$. Apogee $8^d\ 11^h\ m$. Perigee $24^d\ 5^h\ m$, semi-diameter 14′ 45″, 16′ 29″ respectively. Maximum librations $1^d$ 7° W., $7^d$ 7° S., $17^d$ 6° E., $21^d$ 7° N., $29^d$ 6° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 32). At the Full Moon on 26th the Moon enters the Earth's penumbra, and a smokiness will be visible on the Northern portion of the disc. The phenomenon is invisible in Europe.

MARS is still badly placed, but may be observed as a morning star. Semi-diameter 2½″. Width of unilluminated lune ⅓″.

JUPITER is a morning star, in Pisces; stationary on 20th Equatorial diameter 45″, Polar 42″. Width of unilluminated lune ⅔″. Rises at $11^h{\cdot}5\ e$ on 1st, at $9^h{\cdot}5\ e$ on 31st.

Configurations of satellites at $1^h\ 30^m\ m$.

JUPITER'S SATELLITES.

| Day. | West. | | East. | | Day. | West. | | East. | |
|---|---|---|---|---|---|---|---|---|---|
| July 1 | 43 | ○ | 1 | 2● | July 17 | 43 | ⊙ | | |
| ,, 2 | 43 | ○ | 2 | 1● | ,, 18 | 4¾ | ○ | 1 | |
| ,, 3 | 4321 | ○ | | | ,, 19 | 41 | ○ | ¾ | |
| ,, 4 | 243 | ○ | 1 | | ,, 20 | 4 | ○ | 123 | |
| ,, 5 | 1 | ○ | 423 | | ,, 21 | 21 | ○ | 3 | 4● |
| ,, 6 | | ○ | 1243 | | ,, 22 | 2 | ○ | 13 | |
| ,, 7 | 21 | ○ | 34 | | ,, 23 | 31 | ○ | 24 | |
| ,, 8 | 3 | ○ | 14 | 2● | ,, 24 | 3 | ○ | 14 | |
| ,, 9 | 3 | ○ | 24 | 1● | ,, 25 | 32 | ○ | 4 | 1● |
| ,, 10 | 32 | ⊙ | 4 | | ,, 26 | 1 | ○ | 24 | 3● |
| ,, 11 | 23 | ○ | 14 | | ,, 27 | | ○ | 1234 | |
| ,, 12 | 1 | ○ | 324 | | ,, 28 | 1 | ○ | 34 | |
| ,, 13 | | ○ | 4123 | | ,, 29 | 2 | ○ | 134 | |
| ,, 14 | 421 | ○ | 3 | | ,, 30 | 314 | ○ | 2 | |
| ,, 15 | 42 | ○ | 31 | | ,, 31 | 34 | ○ | 12 | |
| ,, 16 | 431 | ○ | 2 | | | | | | |

The following satellite phenomena are visible at Greenwich:—$1^d\ 0^h\ 44^m\ m$, III. Tr. E., $1^h\ 36^m\ m$, I. Sh. I., $2^h\ 59^m\ m$, I. Tr. I.; $2^d\ 2^h\ 27^m\ m$, I. Oc. R., $11^h\ 44^m\ e$, I. Tr. I.: $7^d\ 11^h\ 22^m\ e$, III. Sh. E.; $8^d\ 1^h\ 3^m\ 46^s\ m$, II. Ec. D., $1^h\ 41^m\ m$, III. Tr. I., $3^h\ 30^m\ m$, I. Sh. I.; $9^d\ 0^h\ 44^m\ 29^s\ m$, I. Ec. D., $11^h\ 11^m\ e$, I. Tr. I.; $10^d\ 0^h\ 17^m\ m$, I. Sh. E. $1^h\ 2^m\ m$, II. Tr. E., $1^h\ 35^m\ m$, I. Tr. E.; $15^d\ 0^h\ 7^m\ m$, III.

Sh. I., $3^h\ 21^m$ *m*, III. Sh. E., $3^h\ 38^m\ 10^s$ *m*, II. Ec. D.; $16^d\ 2^h\ 38^m\ 45^s$ *m*, I. Ec. D., $11^h\ 52^m$ *c*, I. Sh. I.; $17^d\ 0^h\ 43^m$ *m*, II. Tr. I., $0^h\ 59^m$ *m*, II. Sh. E., $1^h\ 8^m$ *m*, I. Tr. I., $2^h\ 10^m$ *m*, I. Sh. E., $3^h\ 25^m$ *m*, I. Tr. E., $3^h\ 32^m$ *m*, II. Tr. E.; $18^d\ 0^h\ 37^m$ *m*, I. Oc. R.; $20^d\ 10^h\ 55^m\ 39^s$ *c*, IV. Ec. D.; $21^d\ 2^h\ 18^m\ 45^s$ *m*, IV. Ec. R; $24^d\ 0^h\ 44^m$ *m*, II. Sh. I., $1^h\ 46^m$ *m*, I. Sh. I., $2^h\ 57^m$ *m*, I. Tr. I., $3^h\ 11^m$ *m*, II. Tr. I., $3^h\ 36^m$ *m*, II. Sh. E., $4^h\ 4^m$ *m*, I. Sh. E., $11^h\ 1^m\ 44^s$ *c*, I. Ec. D.; $25^d\ 2^h\ 27^m$ *m*, I. Oc. R., $10^h\ 32^m$ *c*, I. Sb. E., $11^h\ 4^m$ *c*, III. Oc. D., $11^h\ 41^m$ *c*, I. Tr. E.; $26^d\ 0^h\ 33^m$ *m*, II. Oc. R., $1^h\ 53^m$ *m*, III. Oc. R.; $29^d\ 10^h\ 32^m$ *c*, IV. Tr. E.; $31^d\ 3^h\ 22^m$ *m*, II. Sh. I., $3^h\ 40^m$ *m*, I. Sh. I.

Notice that Satellites I and II may be seen simultaneously in transit on the 10th, 17th, and 24th. It will be interesting to compare the satellites and their shadows on these occasions.

SATURN is invisible, having been in conjunction with the Sun on June 28th.

URANUS is a morning star, but badly placed.

NEPTUNE is invisible, being in conjunction with Sun on 24th.

MEAN TIME OF MERIDIAN TRANSIT AT GREENWICH OF CERTAIN BRIGHT STARS.—It has been suggested to me that such a Table as Table 31 would be of service to observers for obtaining time by small transit instruments.

To find the Greenwich time of these stars crossing other meridians, express their longitude in time, diminish it by $9^s{\cdot}83$ for each hour of longitude, then add the result to the above times for West longitudes; subtract it for East longitudes. The times of transit for intermediate days may be obtained by simple interpolation.

METEOR SHOWERS (from Mr. Denning's List):—

| Date. | Radiant. R.A. | Radiant. Dec. | Remarks. |
|---|---|---|---|
| | ° | ° | |
| May 30 to Aug | 333 | + 28 | Swift, streaks. |
| May July ... | 252 | − 21 | Slow, trains. |
| June—Aug. ... | 310 | + 61 | Swift, streaks. |
| ,, —Sept. .. | 335 | + 57 | Swift. |
| ,, —July ... | 245 | + 64 | Swift. |
| ,, —Aug. ... | 303 | + 24 | Swift. |
| July 6-22 ... | 284 | − 13 | Very slow. |
| ,, 15-31 ... | 23 | + 43 | Swift, streaks. |
| ,, 19 ... | 315 | + 48 | Swift, short. |
| ,, 22-27 ... | 335 | + 51 | Swift, streaks. |
| July—Aug. ... | 308 | − 12 | Slow, long. |
| July 25-Sept. 15 | 48 | + 43 | Swift, streaks. |
| ,, 28 ... | 339 | − 11 | Slow, long. This is a conspicuous shower, the July Aquarids. |
| ,, —Sept. ... | 335 | + 73 | Swift, short. |
| ,, 8-31 ... | 317 | + 31 | Swift, white. |
| ,, —Aug. ... | 280 | + 57 | Slow, short. |
| ,, —Oct. .. | 355 | + 72 | Swift, short. |

TABLE 31.

| Star. | α Coronae. | Antares. | Vega. |
|---|---|---|---|
| Declination. | N. 27° 0′. | S 26° 15′. | N. 38° 42′. |
| | h. m. s. | h. m. s. | h. m. s. |
| June 30 ..... | 8 59 46·38 *e* | 9 52 44·75 *e* | 12 2 14·82 *m** |
| July 10 ..... | 8 20 27·16 *e* | 9 13 25·61 *e* | 11 22 55·75 *e* |
| ,, 20 ..... | 7 41 7·94 *e* | 8 34 6·46 *e* | 10 43 36·63 *e* |
| ,, 30 ..... | 7 1 48·67 *e* | 7 54 47·25 *e* | 10 4 17·46 *e* |

* Morning of July 1st.

TABLE 32. Occultations of Stars by the Moon visible at Greenwich.

| Date. | Star's Name. | Magnitude. | Disappearance. Time. | Disappearance. Angle from N. to E. | Reäppearance. Time. | Reäppearance. Angle from N. to E. |
|---|---|---|---|---|---|---|
| 1915. | | | h. m. | ° | h. m. | ° |
| July 1 .. | WZC 1482 ... ... ... | 7·4 | — | — | 1 21 *m* | 217 |
| ,, 2 ... | BAC 8017 ... ... ... | 6·2 | 0 58 *m* | 46 | 2 8 *m* | 248 |
| ,, 4 ... | 51 Piscium ... ... ... | 5·7 | 0 44 *m* | 59 | 1 48 *m* | 238 |
| ,, 8 ... | 16 Tauri ... ... ... ... | 5·4 | 2 39 *m* | 76 | 3 39 *m* | 244 |
| ,, 8 ... | 17 Tauri .. ... ... .. | 3·8 | 2 46 *m* | 124 | 3 22 *m* | 196 |
| ,, 8 ... | 19 Tauri ... ... ... ... | 4·4 | 3 0 *m* | 43 | 3 55 *m* | 276 |
| ,, 8 ... | 20 Tauri ... ... ... ... | 4·0 | 3 8 *m* | 77 | 4 11 *m* | 242 |
| ,, 8 .. | 21 Tauri ... ... ... ... | 5·9 | 3 23 *m* | 35 | 4 16 *m* | 283 |
| ,, 8 ... | 22 Tauri ... ... ... ... | 6·5 | 3 23 *m* | 45 | 4 22 *m* | 274 |
| ,, 24 ... | Lacaille 7849 .. .. ... | 7·0 | 9 25 *e* | 135 | — | — |
| ,, 25 ... | BAC 6814... ... ... ... | 6·3 | 11 20 *e* | 85 | 0 29* *m* | 231 |
| ,, 26 ... | BD—20°·6055 ... ... ... | 7·0 | — | — | 11 7 *e* | 178 |
| ,, 27 ... | WZC 1390 ... ... .. | 7·1 | — | — | 0 33 *m* | 262 |
| ,, 27 .. | WZC 1392 ... ... ... | 6·7 | — | — | 1 14 *m* | 299 |
| ,, 27 ... | 44 Capricorni ... ... ... | 6·0 | — | — | 9 17 *e* | 220 |
| ,, 28 .. | BD—8° 5912 ... ... ... | 6·4 | 10 46 *e* | 110 | 11 29 *e* | 186 |
| ,, 29 ... | 67 Aquarii .. ... ... | 6·3 | 2 2 *m* | 82 | 3 6 *m* | 205 |
| ,, 30 ... | WZC 1569 ... ... .. | 7·4 | — | — | 1 55 *m* | 210 |

From New to Full disappearances occur at the Dark Limb, from Full to New reäppearances.

The asterisk indicates the day following that given in the Date column.

Attention is called to the occultation of the Pleiades on the morning of July 8th.

FIGURE 168. Young Common Seal.

FIGURE 169. Dormouse.

(From "Wonders of Wild Nature," by Richard Kearton. By the courtesy of Messrs. Cassell & Co.)

(See page 192.)

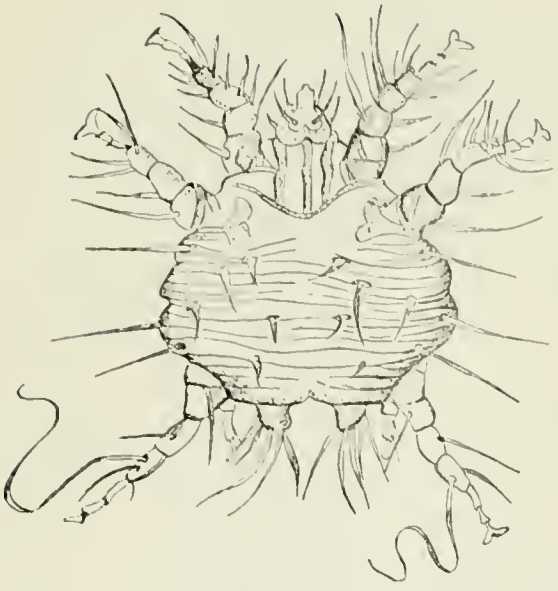


FIGURE 170. Scab Mite (*Psoroptes communis* var. *equi*).

FIGURE 171. A male Plague Flea.

FIGURE 172. A Buffalo Knat (*Simulium meridionale*). ♂

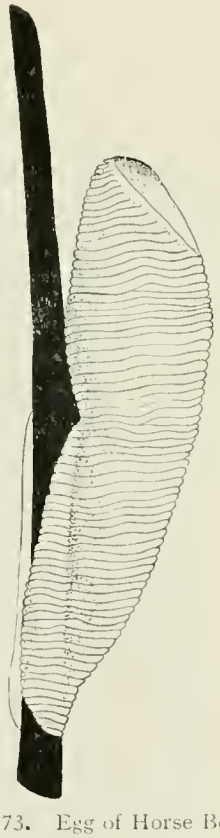


FIGURE 173. Egg of Horse Bot Fly (*Gastrophilus equi*).

(From "Insects and Man," by C. A. Ealand. By the courtesy of Messrs. Grant Richards, Ltd.)

(See page 191.)

TABLE 33. LONG-PERIOD VARIABLE STARS.

| Star. | Right Ascension. | Declination. | Magnitudes. | Period. | Date of Maximum. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | d. | |
| R Trianguli ... ... ... ... | 2 31 53 | +33 53 | 5·3 to 12·0 | 265 | 1915—June 12 |
| S Ursae Maj.... ... ... ... | 12 40 15 | +61 33 | 7·0 to 12·5 | 226 | ,, July 23 |
| R Hydrae ... ... ... ... | 13 25 4 | −22 50 | 3·5 to 10·1 | 425 | ,, Aug. 3 |
| V Ursae Min. ... ... ... | 13 37 10 | +74 45 | 7·5 to 8·7 | 71 | ,, July 28 |
| R Draconis ... ... ... ... | 16 32 25 | +66 56 | 6·4 to 13·0 | 246 | ,, Aug. 2 |
| T Herculis ... ... ... ... | 18 5 53 | +31 0 | 6·9 to 13·3 | 165 | ,, Aug. 5 |
| W Lyrae ... ... ... ... | 18 11 59 | +36 39 | 7·3 to 12·5 | 196 | ,, July 22 |
| UX Cygni ... ... ... ... | 20 51 33 | +30 6 | 7·4 to 13·5 | 565 | ,, July 27 |
| R Vulpeculae... ... ... ... | 21 0 36 | +23 29 | 7·1 to 13·6 | 137 | ,, July 16 |
| W Pegasi ... ... ... | 23 15 30 | +25 49 | 7·3 to 13·0 | 343 | ,, June 30 |

Night Minima of Algol $3^d\ 2^h\cdot3\ m$, $5^d\ 11^h\cdot1\ e$, $8^d\ 8^h\cdot0\ e$, $23^d\ 4^h\cdot0\ m$, $26^d\ 0^h\cdot8\ m$, $28^d\ 9^h\cdot6\ e$, $31^d\ 6^h\cdot5\ e$.
Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of $\beta$ Lyrae July $8^d\ 11^h\cdot5\ e$, $21^d\ 9^h\cdot6\ e$. Period $12^d\ 21^h\ 47^m\cdot5$.

VARIABLE STARS.—Stars reaching their maxima in or near July, 1915, are included. The lists in recent months may also be consulted (see Table 33).

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

# REVIEWS.

## BIOLOGY.

*Insects and Man.*—By C. A. EALAND. 343 pages. 16 plates. 100 figures. 9-in. × 5½-in.

(Grant Richards. Price 12/- net.)

Mr. C. A. Ealand has worthily performed a valuable task, and it is to be hoped that his book will be widely read. Within the last five-and-twenty years, it is true that the public mind has been gradually awakening to the immense rôle played by insects, not only in the economy of nature, but in direct relation to the life, happiness, and wealth of mankind. Written in a popular manner, this work will help to impress us, not only with what has been done, but with what there still remains to do. The importance of trained scientific research is clearly insisted upon; but one might wish that the author had been even more emphatic. To take but one instance. Those who listened at a recent meeting of the Zoölogical Society to Professor Maxwell Lefroy's paper on the Housefly and its means of extermination were painfully reminded of the gaps in our knowledge of the habits of one of the commonest of insects that pave the way to its destruction. Though the housefly has long been known as a carrier of disease and death, especially among infants, yet the number of experts in this country who are studying the problem might be counted almost on the fingers of one hand. No public money is being spent to further the research, and the work is going but slowly forward. True it is still, as it was in the days of Hosea, "My people are destroyed for lack of knowledge."

After an introduction in which a general survey is taken of the structure and life-history of insects, the first chapter deals with the relations of insects to plant life, special notice being taken of those injurious to crops and vines, *e.g.*, the Hessian fly, locust, and phylloxera, in which not only the intelligent public, but the general zoölogist will find much that is novel and interesting. Next come the blood-sucking insects—flies, lice, and ticks—which may be carriers of disease to man, and they occupy some seventy pages. The etiology of malaria, yellow fever, bubonic plague, and relapsing fever is fully described, and the author does justice to the splendid work of the Americans in the Isthmus of Panama. Finally, the enemies of live-stock and human parasites are described, and the book ends with an account of what is being done in the way of insect control. There is an extensive bibliography of the sources of information conveyed in the book, which must not be looked on as a work of reference, but as a stimulating general survey of one of the most important branches of biological science (see Figures 170–173).

M. D. H.

## BOTANY.

*Trees and Shrubs Hardy in the British Isles.*—By W. J. BEAN. 2 volumes. 688 and 735 pages. 9¼-in. × 6½-in.

(John Murray. Price 42/- net.)

Loudon's great work on trees and shrubs grown in Britain has never yet been superseded, but Mr. Bean's book is the most complete treatise of the kind that has appeared since Loudon's, and it naturally includes a considerable number of trees and shrubs that have been introduced into this country during the intervening seventy years. The work is planned on a generous scale. For instance, the first volume contains what might well have been published as an independent book dealing with the general characters of trees and shrubs, methods of planting, and so on, though only occupying one-sixth of this volume. The remainder of the work deals in a detailed manner with an astonishingly large number of species, the genera being taken in alphabetical order—certainly the best arrangement for a work of reference. This encyclopaedic work, lavishly illustrated by clear line drawings, as well as by excellent photographic plates, and showing throughout the sure signs of careful and thorough first-hand experience, is absolutely indispensable to all who are interested, whether for pleasure or profit, in trees and shrubs which grow outdoors in this country. The very magnitude of the work almost forbids criticism, but one could wish that all the larger genera represented had been provided with keys to enable rapid identification of the species; such keys are given in a few cases, however, and, in any case, this is a small point. We have nothing but praise for this magnificent treatise, by far the most complete that has yet appeared on the subject. The price is extremely moderate, considering the size and amount of illustrations.

F. C.

## CRYSTALLOGRAPHY.

*X Rays and Crystal Structure.*—By W. H. BRAGG and W. L. BRAGG. 228 pages. 75 figures. 4 plates. 8½-in. × 5½-in.

(G. Bell & Sons. Price 7/6 net.)

Until a short time ago the atomic theory proposed by Dalton had remained of the nature of an hypothesis, and it is only in the last decade that this conception of matter has

become established on a firm, experimental basis. The book under review brings forward more evidence to confirm the entity of individual atoms. The two component branches of this book are complicated, but Professor Bragg's well-known ability of opening up abstruse avenues of knowledge to those who are not specialists leads us to expect a volume containing much information brought together in an agreeable manner. This expectation has been fully realised. While the mathematical side of the work is not unduly prominent, enough has been introduced to render the facts easily comprehensible.

The work owes its initial stages to the researches of Laue, Friedrich, and Knipping, who not only demonstrated that $x$ rays were propagated by means of waves similar to light-waves, but also were able to show that the space-lattice arrangement of particles in crystals could act as a grating for the diffraction of $x$ rays. Although mathematical difficulties have hindered the practical development of the original procedure, a simplified two-dimensional method devised by the authors has proved very fruitful. The essentially new idea of the Bragg method is due, according to the preface, solely to W. L. Bragg, and is the conception of the "reflection" of $x$ rays. This reflection differs from ordinary reflection of light from a polished surface in that it arises from the diffraction of the rays by the successive planes of particles in a crystal. The results are interpreted by means of the very simple expression $n\lambda = 2d \sin\theta$, where $\lambda$ is the wave-length of the "monochromatic" $x$ rays, $n$ a whole number giving the "order" of the spectrum (analogous to the spectra given by a line grating), $d$ the distance between two successive parallel planes of atoms in the crystal, and $\theta$ the angle between these planes and the incident stream of $x$ rays. Where a number of spectra can be obtained, it is obvious that the measurement of $\theta$ leads to the determination of $d$ and $\lambda$, the latter being of the order of $10^{-8}$ centimetres.

Perhaps the most generally interesting feature is the elucidation of the internal structure of a number of crystals. A comparison of the spectra obtained from sylvine and rock-salt indicates the degree of intimacy with which the crystal structure may be explored. Sylvine gives spectra which show that the structure may be referred to the simple cube-lattice, while, on the other hand, rock-salt must be referred to the face-centred cube-lattice. This observed dissimilarity in the case of two isomorphous substances can only be explained by assuming that it is the atoms, and not the molecules, which act as diffracting centres, and that the scattering power varies as the atomic weight. Further, since a structure formed by the interpenetration of two face-centred cube-lattices would reduce to a simple cube-lattice when the two atoms are of similar mass, the apparently simple structure of sylvine is due to the approximate equality of the atomic weights of K and Cl. The second assumption finds verification in the case of the rhombohedral carbonates, where the first spectrum for the octahedral faces diminishes as the atomic weight of the metal increases, until in the manganese and iron salts, where the mass of the metal is approximately equal to that of the $CO_3$ group, the first spectrum vanishes.

It is interesting to note, in connection with the Pope-Barlow theory, that, while the structure of copper conforms to the closest packed system of polyhedra, that of the diamond is represented by a very loosely packed system. In the latter case the structure assigned by the authors reconciles the conflicting evidence regarding the existence of polarity in the crystal.

The utility of the Laue method in rendering the quantitative nature of the Bragg method more accurate is exemplified in the case of iron-pyrites, where the iron atoms are arranged on a face-centred cube-lattice, the sulphur atoms lying unsymmetrically on a system of non-intersecting trigonal axes. The sulphur atoms divide the latter in the ratio 4 : 1 according to the spectrometer results, and in the ratio 776 : 224 according to the Laue method.

Although this work has proved exceedingly fruitful, it is evident that many experimental difficulties remain to be overcome, particularly where the number of different atoms in the molecule exceeds three. So far as it has gone, however, the results afford striking confirmation of the structural theories of Federov and Schoenflies.

A mild criticism might be offered regarding a nomenclature which applies optical terms, such as "monochromatic" and "white radiation" to denote radiations of homogeneous and heterogeneous wave-lengths respectively.

The letterpress, though generally excellent, is marred by a few arithmetical misprints, and we also note a mistake on page 85, where more care might have been taken in dealing with isotopes.

A. S.
A. F.

## NATURAL HISTORY.

*Wonders of Wild Nature.*—By Richard Kearton. 174 pages. 72 plates, of which four are in colour. 8-in. × 5½-in. (Cassell & Co. Price 6/-.)

Much of Mr. Richard Kearton's work has been upon the rarer of our British birds, which are generally to be looked for in the least accessible and distant parts of these islands. His present book deals, to a considerable extent, with natural history near London; while chapters are devoted to the birds of Holland and Norway. In the first-mentioned country some interesting British birds and visitors, like the spoonbill and purple heron, were met with and photographed; while in Norway, while the same held good, several common British migrants, which do not breed with us, were photographed on their nests. There is plenty of interesting incident in the letterpress.

Mr. Kearton's readers will remember his taking photographs from inside an artificial cow; but in Norway, when getting photographic records of redwings' nests, he was attacked by a very real bull. Those who are engaged in the work of bird-protection will be glad to hear that the Sanctuary, established for the great skua in the Shetlands some fifteen years ago, has been most successful. The way in which Mr. Kearton persuaded a hen Dartford warbler to alight on his hand to feed one of her fledglings may also be mentioned. We think that Mr. Kearton's book shows that there is still a vast amount of natural-history material to draw upon for the benefit of nature-lovers and the public. We are kindly permitted to reproduce two of the illustrations, of which there are seventy-two from photographs by the author and his daughter, Miss Grace Kearton (see Figures 168 and 169).

W. M. W.

# NOTICES.

CUMBERLAND NATURE RESERVE ASSOCIATION.—The Secretary of the Cumberland Nature Reserve Association, Mr. Linnaeus E. Hope, F.L.S., of the Municipal Museum, Carlisle, appeals for subscriptions to the watchers' fund. In 1914, the first year of its existence, the Association supervised several eyries of the peregrine falcon, the buzzard, and the raven, from which all the broods were successfully reared. It also provided funds for the Kingsmoor Nature Reserve, Carlisle, where the local Committee has secured this piece of common land as a nature reserve.

PHOTO-MICROGRAPHY.—We have received from Messrs. Kodak, Limited, the third edition of an introduction to photography with the microscope, which was originally brought out in 1907, when Messrs. Wratten & Wainwright prepared a set of colour filters for use in photo-micrography. As is well known, Messrs. Kodak have taken over the work of the last-mentioned firm, which now forms their Wratten division. The advantages which are gained by use of the filters, especially in conjunction with the special M plate, are very great, as we shall show in our next number

# Royal Naval Division

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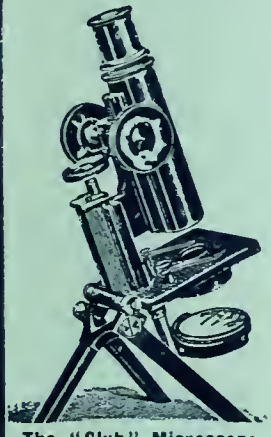

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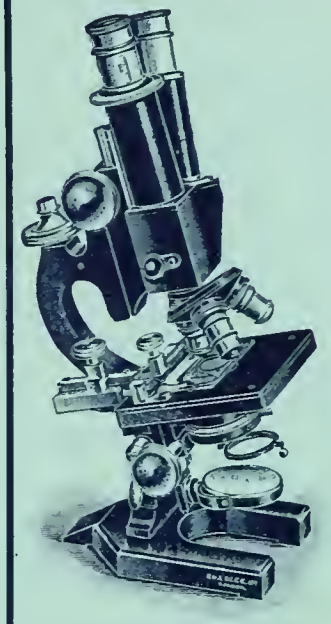

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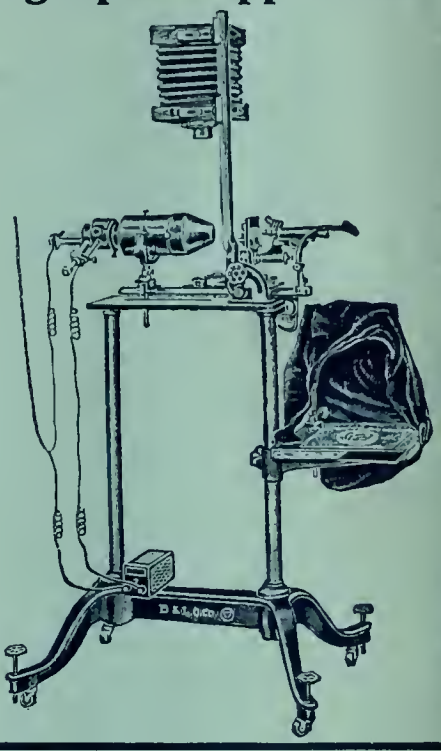

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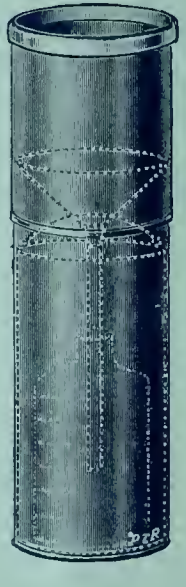

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